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FIELD TRIP JUNE 1961

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DESK & DERRICK FIELD TRIP

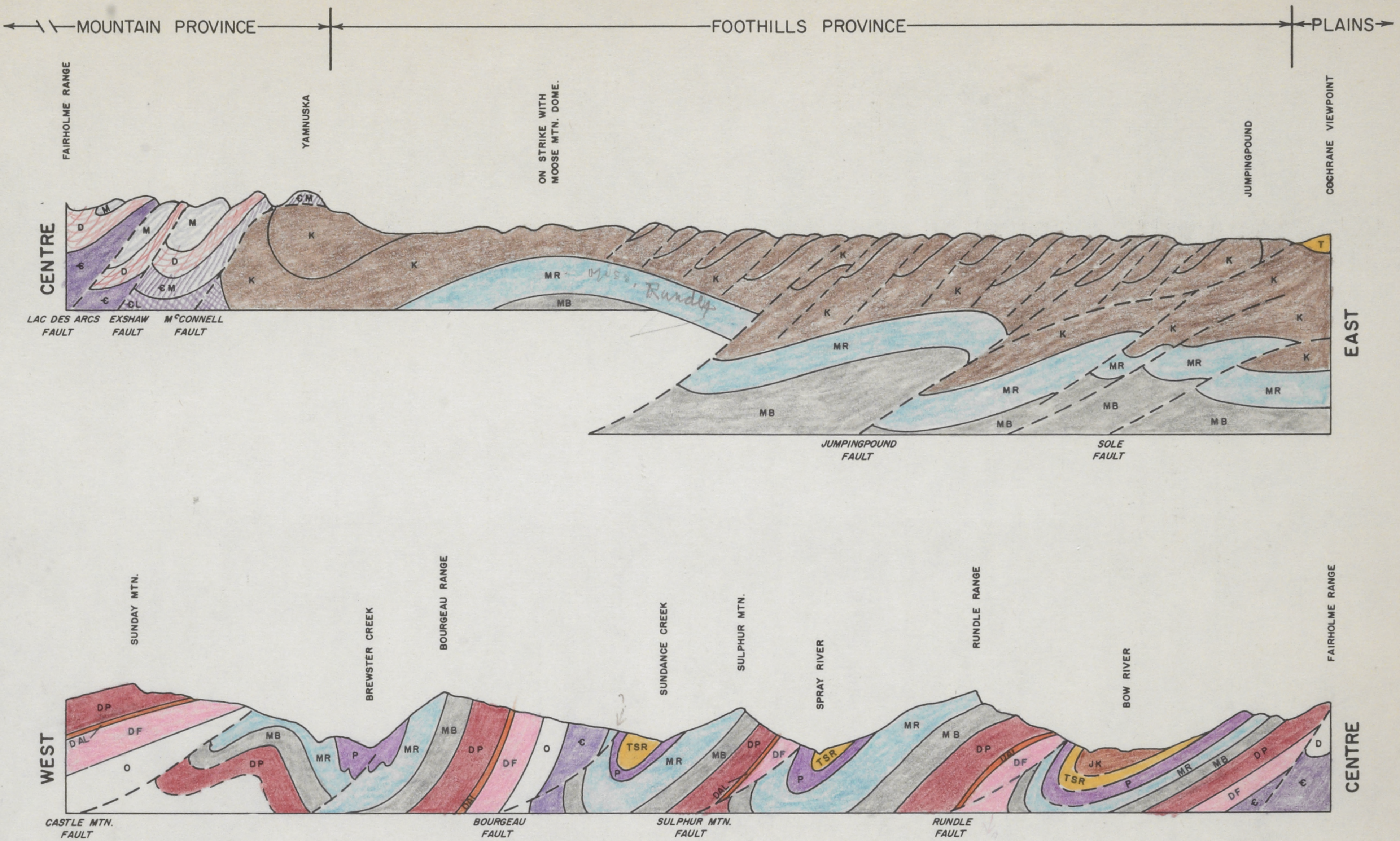
BANFF AREA

JUNE 10 & 11th, 1961

Our field trip this year will take us up the Bow River Valley from the plains area of Calgary to the foothills area of Cochrane, Jumping Pound and Seebee, across the frontal mountain ranges at Mt. Yamnuska, through the "Gap" to Banff town. Field trip stops have been arranged for along the way to point out the features of each of these geological provinces. We trust this will all contribute to your better understanding and appreciation of the natural beauty that abounds us. Indeed we are fortunate to live in this general area which nature has so abundantly endowed with wonders.

The Bow Valley, above Calgary, was inhabited by Indians, both peaceful in purpose and wise in their ways. Later came the law and the missionaries. These were followed by the railway and the ranchers and cow punchers, until today when Banff is only 90 minutes away from Calgary by a new four lane highway.

Thanks are herewith given to Imperial Oil for doing the printing of this book and to D. Duff, B. Kirker, J. Grey and B. Maginley for compiling the book and acting as guides for the field trip.



CROSS SECTION

PLAINS — FOOTHILLS — MOUNTAINS

FIGURE No. 1

Today's field excursion route leads from Calgary, via the Jumping Pound gas field and Seebe to Banff. The Plains, the Rocky Mountain Foothills and Front Ranges sub-province rock exposures will be discussed and structures typical of the foothills and mountains will be seen along the route.

From the intersection of 16th Avenue and 14th Street north-west the route is underlain by early Tertiary Paskapoo sandstone on the east flank of the large broad regional Alberta syncline.

Shortly after leaving the Calgary city limits you will note glacial gravels in the road cuts and the general topography becomes quite hilly. Such topographic expression is referred to as "Knob and Kettle" and is the result of the glaciers which at one time covered the entire area.

Ten miles west of Calgary the road leaves the glacial deposits and proceeds along a pre-glacial plain, formed of early Tertiary Paskapoo formation. At Mile 17 the approximate axis of the Alberta syncline is crossed and at Mile 18.2 the first stop is reached. The Cochrane View-Point is situated on the west limb of the Alberta syncline and is formed of Paskapoo sandstone of Tertiary age.

STOP NO. ONE - COCHRANE VIEW-POINT - ELEVATION 4,300 FEET

The view from this point affords an excellent panorama of three physiographic provinces evident from east to west, namely the Plains, Foothills and Rocky Mountain Front Ranges. Below the hill is the Bow River Valley with its old terrace levels indicating past elevations of the Bow River.

An attempt to permit a visualization of the three physiographic provinces which may be observed at this point are shown on the accompanying Figure No. 1.

The Plains province extends from just west of Cochrane a distance of some 800 miles to the east and is an area in which the sediments are relatively flat-lying and undisturbed by any earth movements. As one approaches toward the present mountain front the sediments thicken and at our present position about 15,000' of strata underlie us.

The Foothills province extends from just west of Cochrane to the precipitous mountain front which forms the first range of the mountains. This is an area in which the rocks have been disturbed by the mountain building mechanisms to the west. In general, the foothills, or disturbed belt, is marked by a series of long trending ridges with local anticlinal or synclinal features. Within this

province one may see that rocks can bend and flow when under pressure. Further, the results of weathering on various types of rocks can be observed. In general the ridges are composed of resistant sandstones and conglomerates and the valleys Eastern West of eroded shales. The dip of the rocks in general is to the west.

The Front Ranges province is not unlike that of the Foothills belt, but the limestones, etc. which comprise this province are more homogeneous and resistant to erosion and hence the larger displaced blocks of strata yield the spectacular form of the mountain ranges.

Detailed accounts of these various aforementioned features will be given at strategic points from which the more obvious and interesting stratigraphic and structural features can be observed.

Upon leaving the Cochrane View-Point and proceeding down the Cochrane Hill exposures of Tertiary Paskapoo sandstones are to be seen. This sandstone was quarried north of the area and used to construct portions of the R.C.M.P. barracks and C.P.R. station in Calgary.

From Cochrane to the Jumping Pound gas plant the beds crossed are alternate strata of Cretaceous Edmonton, Belly River, Wapiabi and Blackstone formations.

JUMPING POUND PLANT - STOP #2

The Jumping Pound gas field is situated near the eastern edge of the foothills belt, some distance north of Turner Valley and about 22 miles west of Calgary. The field area is about 14 miles long and varies in width from about one-half mile to two miles.

The surface geological features are quite similar to those of Turner Valley, located some 24 miles to the south. The surface is marked by a series of parallel NNW - SSE ridges, conforming with the strike of the strata and roughly parallel to the mountain front to the west. Differential erosion is the primary agent in fashioning the landscape. The ridges being formed of the more resistant Belly River Sandstones and the valleys are eroded out of the underlying Wapiabi shales.

The asymmetrical fold located to the west of the outcrop of the Jumping Pound thrust fault is a north offset to the Turner Valley fold, but varies greatly at depth. The Jumping Pound surface fold only involves rocks of Cretaceous age, whereas in the Turner Valley surface structure, beds down to and including the rocks of Mississippian age are involved.

Below the Jumping Pound fault and above the sole fault, folded and faulted Mississippian Rundle rocks create the trapping mechanism and reservoir for the gas accumulation in the field. The undisturbed Rundle below the sole fault is water bearing.

Average depth to production is about 9,500 feet. Production is from about 150' net section in the Upper and Lower Porous zones. Rock type of the reservoir is dolomite. Mississ. Rundle

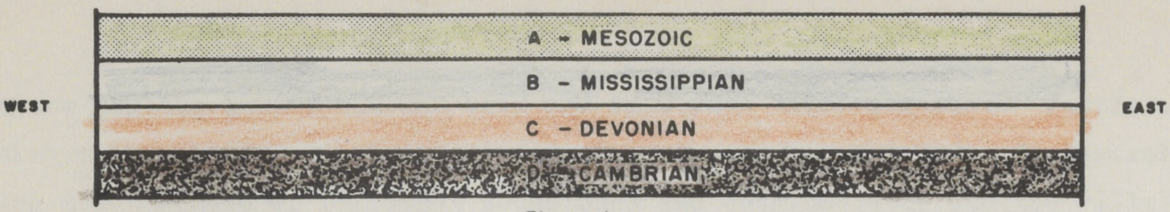


Figure I

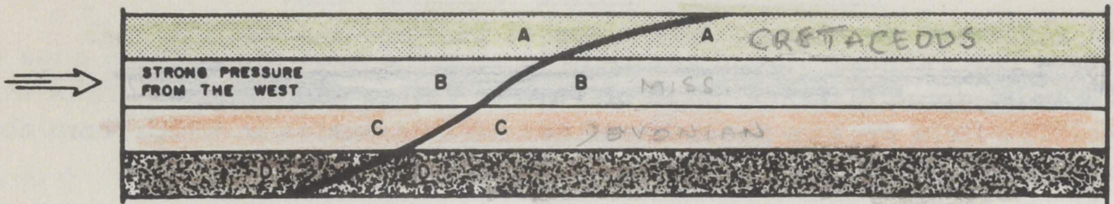


Figure II

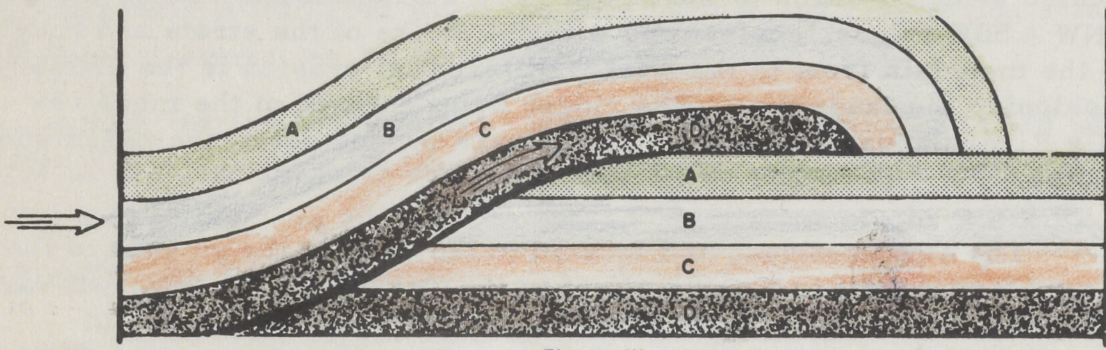


Figure III

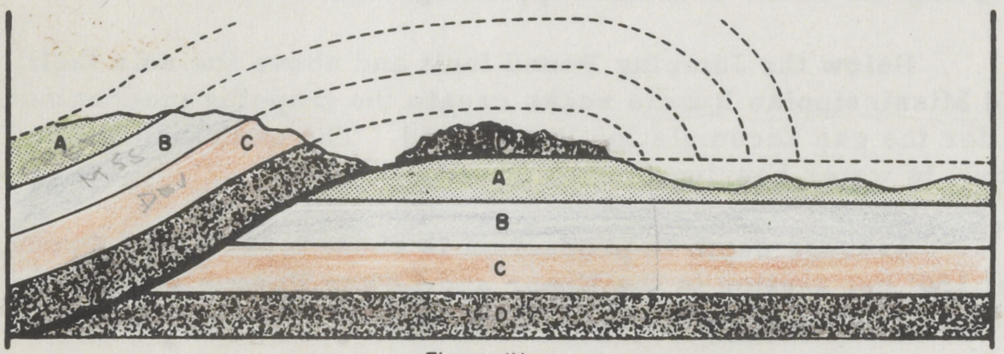


Figure IV

MOUNT YAMNUSKA

Stop Number 3

Fig. 2

SEEBE DAM & MOUNT YAMNUSKA

Stop No. 3.

Mount Yamnuska is of interest in two respects. It shows, in vertical cross-section more vividly probably than does any other mountain in the entire Rockies, the fundamental mechanics of mountain building, Secondly, because of the excellence of the exposure the recorded studies of this mountain have been of very considerable importance in the history of the evolution of geolocical thinking concerning the formation of mountain belts.

Successive stages in the development of the present mountain are illustrated diagramatically in the figures to the left.

Figure I: The present Rocky Mountain belt was a deep seaway during much of the past billion years. Within the seaway, upwards of 50,000 feet of sediments accumulated, ultimately to compact into firm rock. The important point to be noted is that in this, as in any normal succession of strata, the oldest beds are bottom and are successively younger to the top.

Figure II: In late Cretaceous time, the Rocky Mountain area was squeezed together by forces deep in the crust. The rocks ultimately ruptured along the lines of weakness. These surfaces of rupture are called 'faults'.

Figure III: Continued action of the stresses from the west caused ruptured blocks to ride up over the unbroken strata. At Mount Yamnuska this eastward horizontal movement was probably not less than 10 miles. In some areas of the Rockies, horizontal displacements exceeding 30 miles have been recorded.

Figure IV: By early Tertiary time, the movement was essentially complete, and the rocks became targets for the eroding action of rain and frost, so that today only an isolated block of ~~Devonian~~ CAMBRIAN strata remains of the thick layer of strata that was originally shoved eastward over the plains. It has been commonly remarked that this mountain is upside down. True, the older strata (~~Devonian~~ CAMBRIAN) are on top and rest upon younger (Cretaceous) strata - the reverse order from that of a normal succession. It is obvious when the facts are known that the 'upside down' condition is more apparent than real.

This remarkable phenomenon was studied first in 1885 by the Canadian Government geologist R. C. McConnell. This was its earliest recognition in North America. The fault has since been named the 'McConnel Fault'. Such structures are now known to be common throughout the entire length of the Rocky Mountain belt.

May 23/86
Yamnuska Cambrian rock
pushed 20 miles from
West, was 1600' down.

Geology Field Trip with
Kerby Centre bus.
Dr. Len HILL, U of C.

SEEBE

At a point approximately forty miles from Calgary on the former Trans-Canada Highway we turn off to Seebe, the site of two of Calgary Power Ltd's dams on the Bow River. The Bow drainage basin supplies essentially all the hydro-electric power in Alberta. The Calgary Power transmission system extends from a point 130 miles north of Edmonton to the United States border.

The Bow River is a typical mountain river. West of Calgary it drains an area of 3,128 square miles of which that part above the Kananaskis Falls, 1,710 square miles in extent, may be considered to lie wholly in the Rocky Mountains. It has a very steep slope and in several places falls occur. The head waters of the river lie at an elevation of about 6500 feet above sea level. The flow of the river is typical of all mountain streams, subject to sudden variation and greatly influenced by conditions of temperature. During the winter months the flow is much reduced but in the hot summer months of June and July the floods occur and the variation between high and low water is very great. It has been computed from levels taken by the Canadian Pacific Railway Company at Bow Bridge and Kananaskis Bridge that at Kananaskis Falls just below the mouth of the Kananaskis River, a flood of 45000 C.F.S. has occurred. A low Water discharge of 550 C.F.S. has been recorded at the same point.

The two plants, the Kananaskis which is located close to the junction of the Kananaskis River and the Bow River, and the Horseshoe plant located two miles down stream develop about 1/5 of the power derived from the Bow. The Kananaskis plant develops 24,000 H. P and the Horseshoe, 20,000 H. P; producing together about 200 million Kilowatt hours annually. Both plants have been constructed on outcrops of Cardium sandstone. In this vicinity ther are two main sands in the Cardium zone. As we progress downstream from the Kananaskis plant we see the Cardium exposed on both limits of an arch or anticline in the stream bed. The Cardium at this locat is very similar in grain size to that which is producing at Pembina, with the upper sand closely associated with black chert pebble conglomerates, again similar to Pembina. The Cardium is overlain by black marine shales of the Wapiabi formation and underlain by similar shales of the Blackstone formation. These sediments indicate that during their depositional period the area was a broad ocean into which was carried these fine silt size particles of Cardium sand probably derived from an uplifted and eroding area far to the west.

Stop No. 4. LAC DES ARCS - EXSHAW

From this viewpoint we are looking across Lac des Arcs at a cross-section of the Fairholme Range called the first range of the Front Ranges Sub Province. A broad areal definition of the Front Ranges Sub Province is that area bounded on the east by the McConnell thrust fault and on the west by the Castle Mountain thrust fault. The Front Ranges Sub Province comprises from east to west, the Fairholme, the Cascade-Rundle, the Norquay-Sulphur-Goat, the Sawback-Bourgeau and the Pilot-Fatigue Ranges. (All will be visible from the top of Sulphur Mtn. Stop No. 6). Excepting the latter, each range is underlain by a major fault; the Pilot-Fatigue Range is closely tied to the Sawback-Bourgeau Range, the two being separated by the Brewster Creek Syncline.

The Fairholme Range includes those mountains bounded on the east by the McConnell fault and on the west by the Rundle fault. At least two lesser faults occur within the Fairholme Range but their geologic and surface expression is not particularly distinct; hence the Fairholme Range is topographically one unit but structurally three units. From our vantage point on the south side of Lac des Arcs we can look across the lake and view the expression of these two lesser faults within the Fairholme Range. The easterly of the two is located at the base of the east slope of the mountain being worked by the Canada Cement Company. Following in a westward direction from the Exshaw fault a normal sequence is seen; Devonian Palliser carbonates (Source material for the cement plant), the Exshaw shale, the Mississippian Banff, then a slice of Mississippian Rundle. At this point we observe the trace of the Lac des Arcs fault that brings rocks of Cambrian age up to the surface, sitting on the aforementioned Rundle and Banff. From here to the western edge of Grotto Mtn. we cross through a normal sequence of Cambrian, Devonian and Mississippian rocks with Permian and Triassic on the back slope of Grotto.

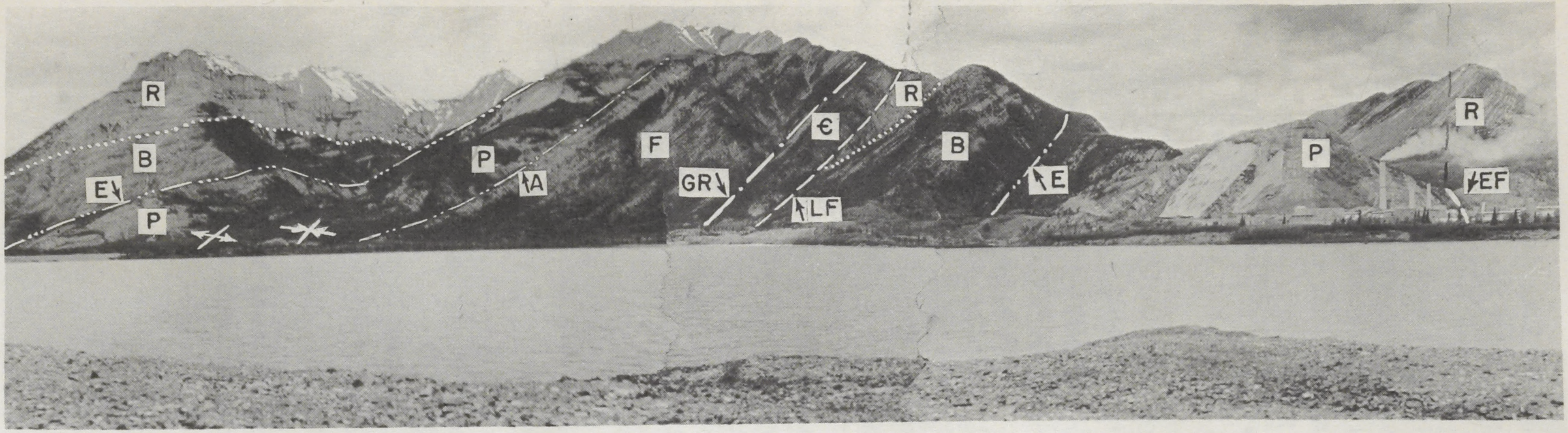
The highway crosses the trace of the Lac des Arcs fault, about 350 yards to the west of our stop.

To the south-east of our stop, we see Heart Mountain. This mountain is located between two branches of the Exshaw fault. The massive ridge from the road to the mountain peak is composed of Rundle strata. On the back slope is Rocky Mountain and Triassic strata. The mountain takes its name from the synclinal fold in the peak.

Immediately behind us is the same small thrust block as we see across the lake from where Canada Cement Company mine the Palliser carbonates.

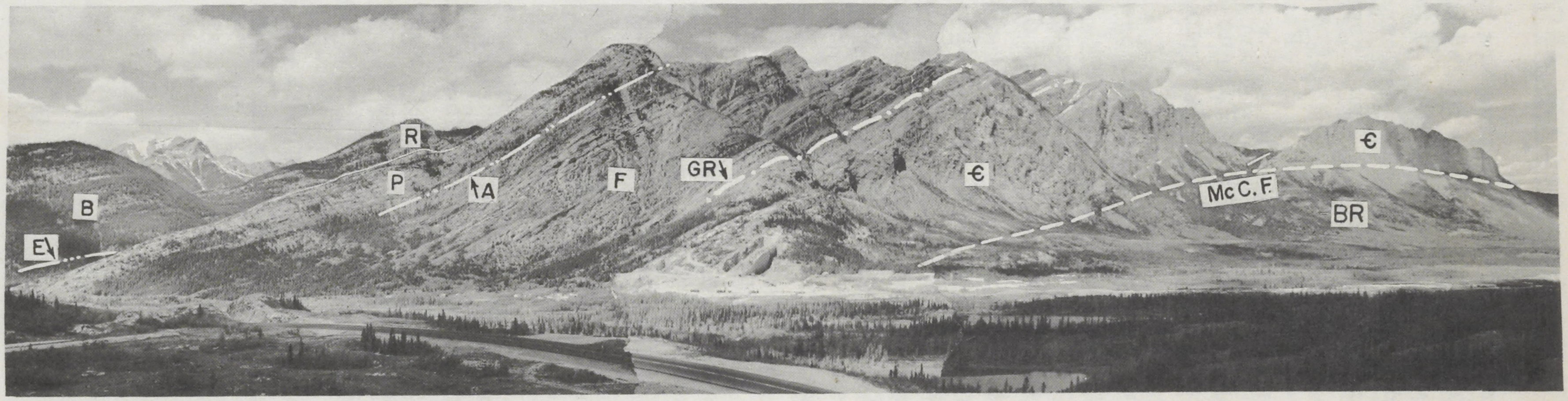
WEST

CENTRE



CENTRE

EAST



Panorama of Fairholme Range, looking north from Bow River. Grotto Mountain on the west, Canada Cement Plant in centre, Loder Lime Plant and Yamnuska Mountain on the east. Lower photograph taken near parking area at mile 44.1; upper photograph, at mile 47.4, Road Log No. 1. McConnell fault (McC.F.), Exshaw fault (E.F), Lac des Arcs fault (L.F), Cambrian (C), Ghost River (GR), Fairholme (F), Alexo (A), Palliser (P), Exshaw (E), Banff (B), Rundle (R), and Belly River (BR). Annotation partly after L.M. Clark. Photographs by W. Wegmuller and R. Umiker.

Figure 3

To the southwest, across the Lac des Arcs fault, is Mt. Duncan McGillivray, Rundle strata forms the prominent scarp face at the top. This scarp is underlain by the more recessive Banff, below this is the prominent Palliser and then a part of the more recessive Fairholme. At this point the Lac des Arcs fault only brings the aforementioned Fairholme over the Rundle, whereas across the the lake we have seen this fault bring beds of Cambrian age over Rundle. Hence the magnitude of the stratigraphic throw is much less on the south side of the lake.

To the west of the Mt. Duncan McGillivray, is seen Pigeon Mountain, an extension of Grotto Mountain located across the Bow Valley. Pigeon Mtn. is capped by Rocky Mountain formation on the back slope. Rundle limestone forms the uppermost cliff, lower slopes are in Banff rocks, with Palliser exposed at the base.

The Canada Cement plant will produce on full operating capacity, about 8,000 bbls. of cement per day. Shale, mined from the fossiliferous Cretaceous Blackstone at Seebe, is added to the principle material, raw limestone, in the manufacturing process. This plant has been in operation since 1907, expanding its capacity periodically to keep pace with the growing demand.

Cretaceous
Upper { Bear Paw
Belly River
Wapiabi
Cardium
Blackstone
Lower { Blairmore
Kootenay

Jurassic - - { Kootenay
Fernie

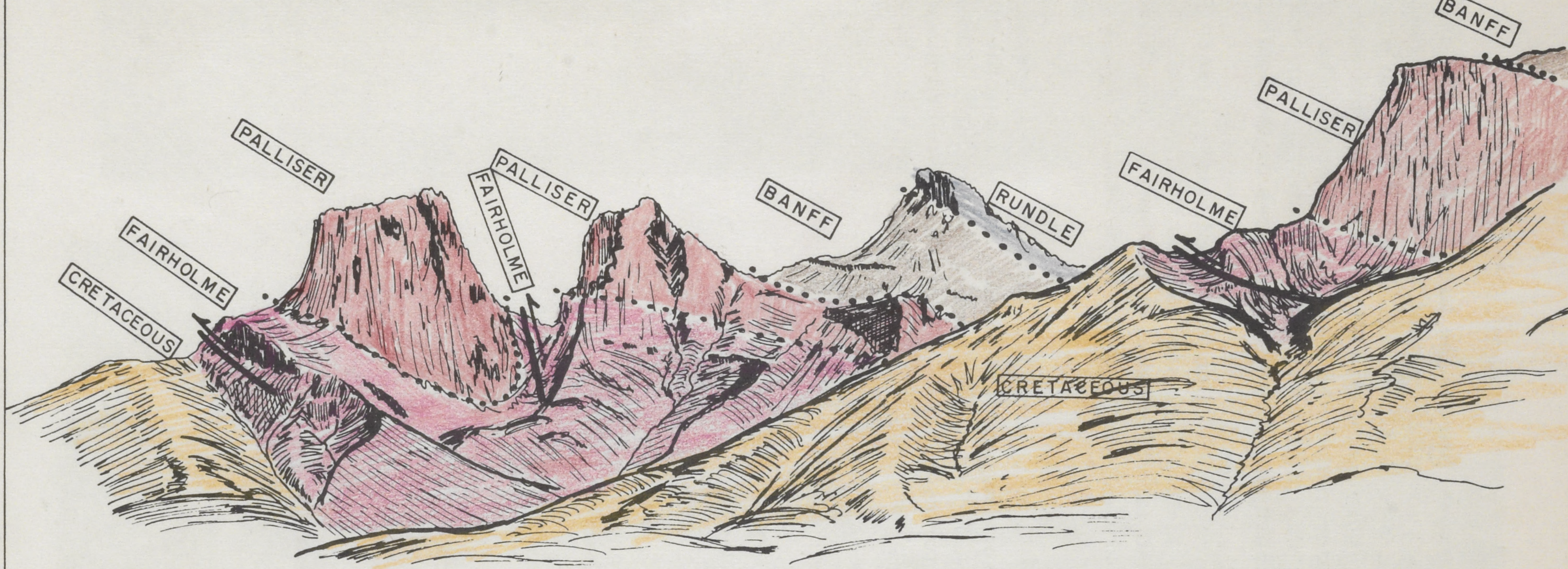
Triassic ... Spray River

Permian .. - Rocky Mtn.

Pennsylvanian
Mississippian ... { Tunnel Mtn
Mt Head
Livingstone
Rundle
Banff
Exshaw

Devonian
Palliser
Fairholme < Alexo
Ghost River

Silurian



THE THREE SISTERS - RUNDLE RANGE

FIGURE No. 4

Stop No. 5. **CANMORE**

Canmore is a small coal mining town of approximately 2,000 people and is at the present time actively mining coal from the Jurassic-Cretaceous Kootenay coal measures.

To the west lies the Rundle Range. The cliff along the crest is formed of Rundle limestone and the shale slopes below are comprised of the Banff formation both of which are Mississippian in age. The lower cliff face is Palliser formation and the forested slopes below are the Fairholme formation, both of which are Devonian in age. Rocks of Cambrian age underlie the Devonian. This range exhibits a structural-physiographic profile typical of the Front Range sub-province.

The road which is visible on the mountain side leads to the Calgary Power Spray Lakes power development, composed of three hydro plants which were completed in 1951. The Spray Lakes drainage system located west of the Rundle Range has been diverted and forced to flow through a canal and tunnel into the Bow River at the base of the road. The water drops a vertical distance of 905' and produces 62,000 horse-power. An additional 27,000 horse-power is developed by the other two plants.

To the southwest may be seen the Three Sisters, which attain an elevation of 8,550'. The most easterly peak is formed of Devonian Palliser and Fairholme strata. A small fault lies just west of this peak and a normal sequence of Fairholme, Palliser, Banff and Rundle comprises the other two peaks, (Figure No. 4).

The large U-shaped valley in which we are standing is referred to as the Cascade Coal Basin and is cut in Mesozoic strata in approximately the axis of the synclinal basin. This basin extends a distance of 45 miles in a northwest - southeast direction and to the south the syncline may be observed where the approximate centre of the basin is situated.

On the east side of Canmore rise the Fairholme Mountains, which are designated the First Front Ranges of the Rocky Mountain Front Ranges sub-province. The rocks from the valley floor up decrease in age from Jurassic to Mississippian Rundle and Banff, which form the crest of the range.

Stop No. 6. SULPHUR MOUNTAIN RIDGE

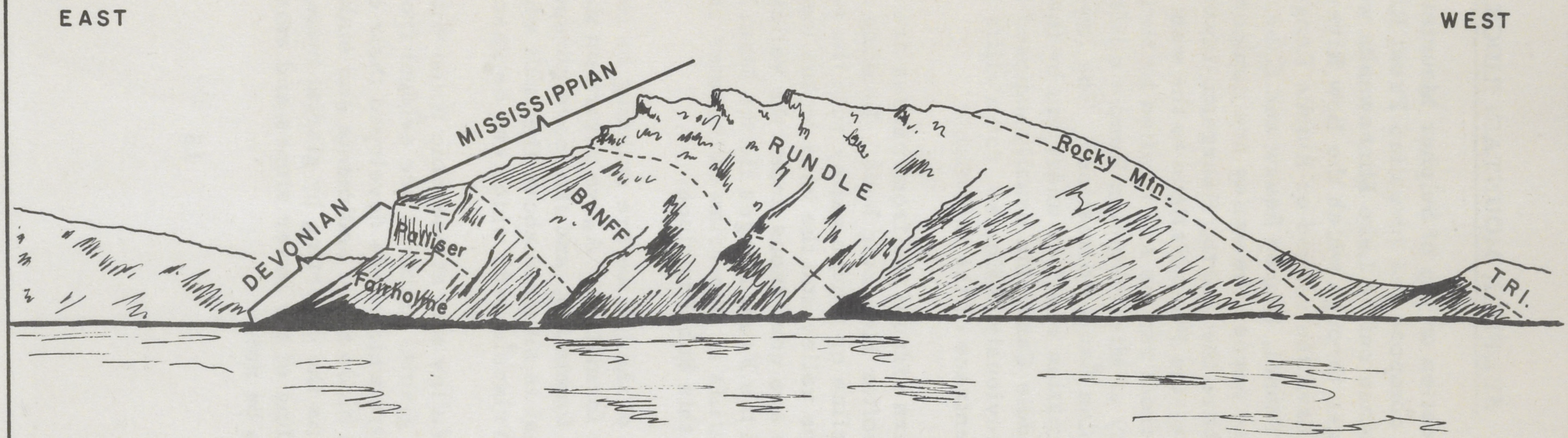
At this location on top of Sulphur Mountain we are on the third of the four ranges which compose the so-called Front Ranges Sub Province at this latitude. In the distance cut by Lake Minnewanka we have the first or Palliser-Fairholme Ranger through which the Bow River cuts at Exshaw Gap. Immediately in front we have the second or Rundle Range which includes the Three Sisters, Rundle, Tunnel, Stoney Squaw and Cascade Mountains. Sulphur Mountain and Mt. Norquay across the valley are components of the third or Goat Range. To the west we have the fourth, Bourgeau-Sawback-Sundance Range with an extra subsidiary range, the Pilot-Fatigue to the west being considered as part of this range. The front ranges are typified by their step-like steep eastern face composed mainly of Mississippian Rundle cliffs at the top underlain by the recessive Mississippian Banff Formation. The lower cliff faces are composed of Devonian Palliser formation which is underlain by the more recessive Devonian Fairholme with some middle Cambrian usually exposed at the base. These Cambrian beds as we have previously indicated, form cliffs along the McConnell fault at Mt. Yamnuska at the entrace of the mountains.

The western sideoof the front ranges are usually more gentle dip slopes composed of the softer Mesozoic beds. Looking north and westerly the Bow River runs in a syncline or trough valley with the beds on the Sawback Range dipping to the west into the valley and the beds on the west side of the valley dipping to the east. These beds are continuous under the valley and form the Bow Valley Syncline. To the west of the Front Ranges lie the Main Ranges Sub Province which are typified by massive cliffs of Cambrian carbonates usually flat lying. ~~Mount Eisenhower~~ is typical of this Sub-Province.
Castle Mtn.

At the top of the lift we are standing on fossiliferous carbonates of the Mississippian Rundle formation. As we return on the gondola we will cross over the recessive Banff formation, and the more abrupt face of the Devonian Palliser. The lower terminal is situated above the fault which carries these Paleozoic beds over the Mesozoic Triassic beds which can be seen in the cut of the Spray River.

The Bow Valley was at one time filled with ice with only the high peaks protruding. Many glacial features are evident from this vantage point. The Hoodos are glacial deposits which have developed their characteristic form because of the lime content which binds these sediments and makes them more resistant to erosion. Features such as the diverting by glacial material of the Bow River around Tunnel Mt. and the rounding of the lower slopes and smaller mountains eg. Stoney Squaw or Tunnel can also be noted.

MT. INGLISMALDIE



LAKE MINNEWANKA

(Looking Southeast)

FIGURE No. 5

Stop No. 7 LAKE MINNEWANKA

Observations:

1. Mount Inglismaldie

(a) Note the dip of the beds to the west. The oldest rocks to the east and the youngest to the west.

(b) The Devonian strata, Palliser formation is evident by the lowest steep cliff on the left of Mount Inglismaldie. It is underlain by the Fairholme formation in which the reef deposits of Leduc and Redwater occur.

(c) These are overlain by Mississippian strata of which you can see the Banff and Rundle formations. The latter formation forms the cliffs of the upper part of Mt. Inglismaldie. Turner Valley produces from the Rundle formation

(d) The Rundle formation is overlain by beds called the Rocky Mountain formation of Permian age. They form the western slope of the mountain and outcrop, here, around the west end of the lake.

(e) The latter beds are overlain by beds of Triassic age called the Spray River formation in this area. The hill to the extreme right is composed of these beds. These rocks are a common building stone within the Park. The contact between the Triassic and Permian beds is exposed in the north Spillway at the west end of the lake.

2. Origin of Lake Minnewanka (Devil's Lake)

(a) The lake was once occupied by an alpine glacier. Its present elevation is about 4800 feet above sea level which is 300 feet above the level of Bow Valley. A lobe of the Bow Valley glacier moved east through this valley.

(b) The early drainage of the Bow flowed east through this valley.

(c) The Cascade River once flowed east through the lake.

(d) Glacial deposits blocked the old channel at the east end of the lake and a new outlet was found at the west end of the lake for Cascade River.

(e) A power project by Calgary Power Co. has raised the water level and the lake now has two outlets:

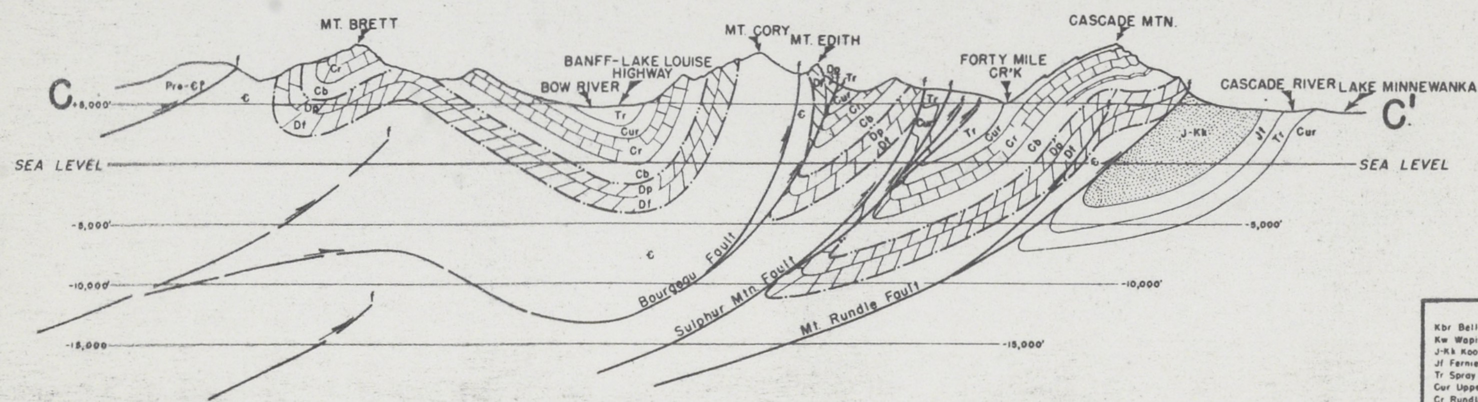
1. The diversion canal.
2. Over the spillway into the old Cascade River channel.

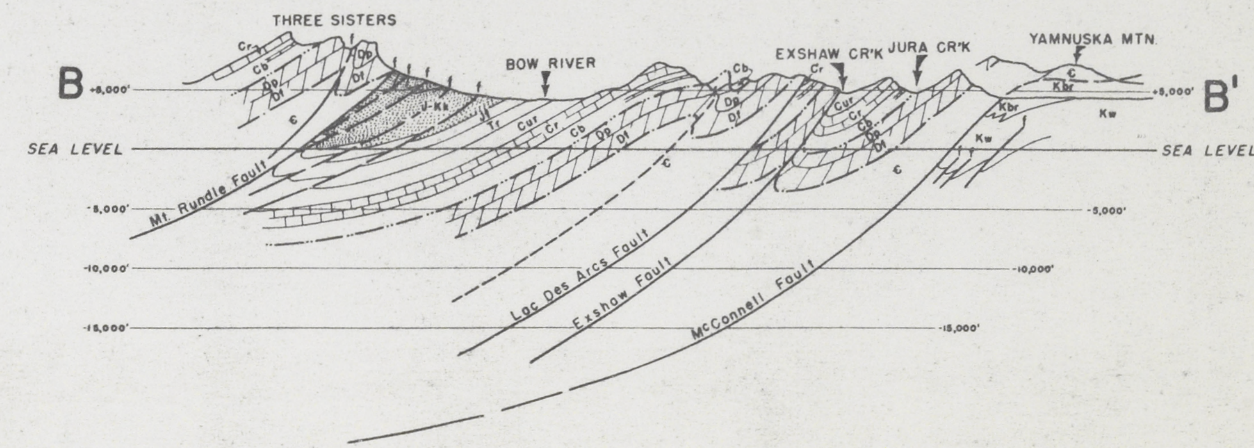
A diversion canal at the east end of the lake brings water from Ghost River into the lake.

See: AAPG
Vol. 33, No. 4 April 1949.

CROSS SECTION ACROSS THE FOOTHILL BELT
&
EASTERN RANGES OF THE ROCKY MTS.

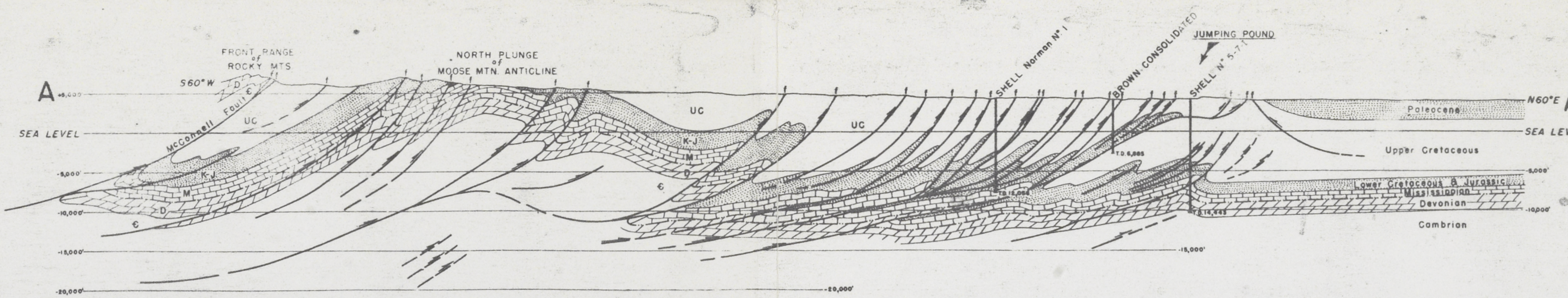
by
L. M. CLARK





Legend for B-B' & C-C'

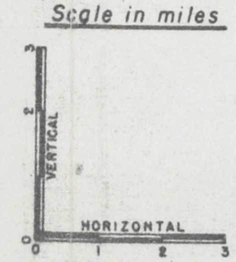
Kbr Belly River }
Kw Wapiabi } Upper Cretaceous
J-Kk Kootenay-Jurassic? -Lower Cretaceous?
Jf Fernie-Jurassic
Tr Spray River-Triassic
Cur Upper Rundle & Rocky Mtn-Upper Mississippian, Pennsylvanian & Permian?
Cr Rundle }
Cb Banff } Middle & Lower Mississippian
—·—Exshaw }
Dp Palliser } Upper Devonian
Df Fairholme }
—·—Ghost River Middle Devonian?
C Cambrian Undifferentiated
Pre-C Pre Cambrian



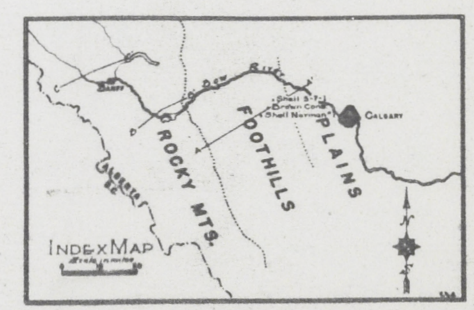
Legend for A-A'

P-Paskapoo-Paleocene
UC-Edmonton, Belly River & Colorado Shale-Upper Cretaceous
K-J-Blairmore, Kootenay & Fernie-Lower Cretaceous & Jurassic
M-Rundle & Banff-Mississippian
——Exshaw-Upper Devonian
D-Upper Devonian, Undifferentiated
C-Cambrian

Scale in miles



JULY 10-1950



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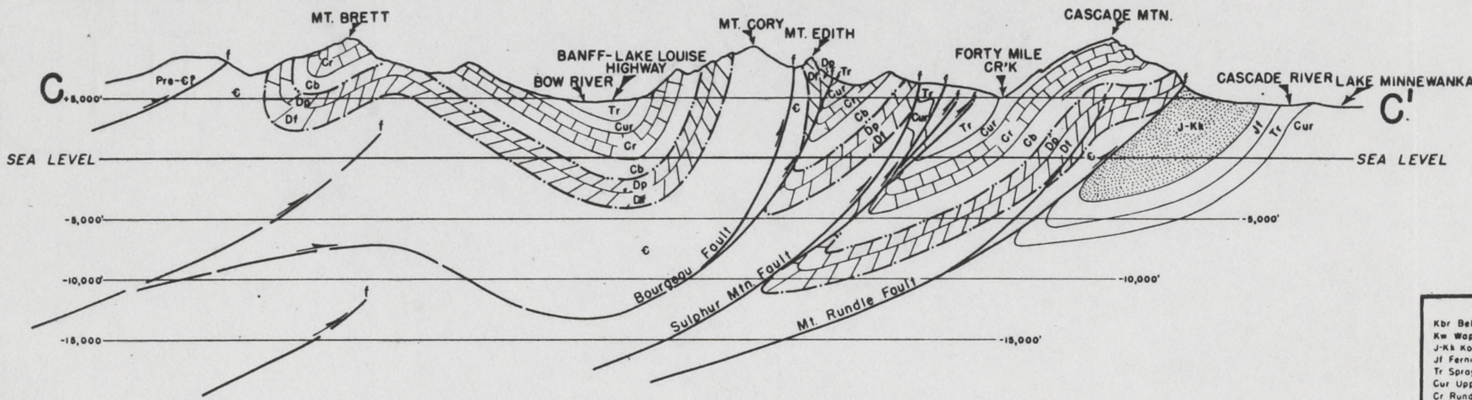
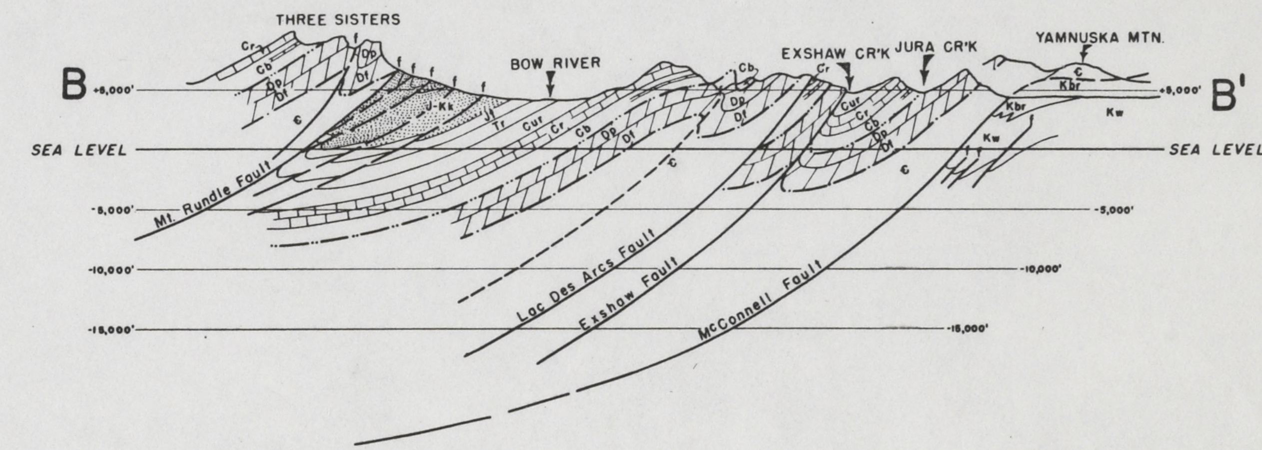
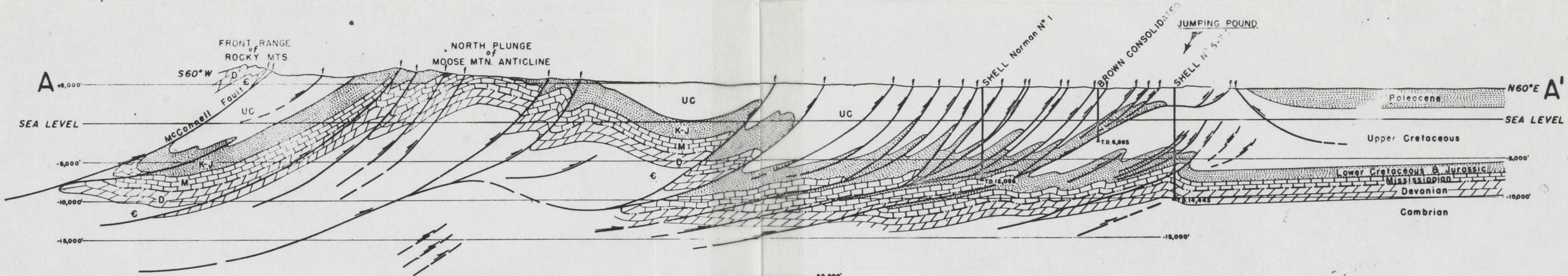




Legend for B-B' & C-C'

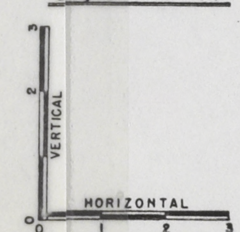
Kbr Belly River } Upper Cretaceous
Kw Wapiabi
J-Kk Kootenay - Jurassic? - Lower Cretaceous?
Jf Fernie - Jurassic
Tr Spray River - Triassic
Cur Upper Rundle & Rocky Mtn - Upper Mississippian, Pennsylvanian & Permian?
Cr Rundle } Middle & Lower Mississippian
Cb Banff
—..— Exshaw } Upper Devonian
Dp Palliser
Df Fairholme
—.— Ghost River Middle Devonian?
€ Cambrian Undifferentiated
Pre-€ Pre Cambrian



Legend for A-A'

P - Paskapoo - Paleocene
UC - Edmonton, Belly River & Colorado Shale - Upper Cretaceous
K-J - Blairmore, Kootenay & Fernie - Lower Cretaceous & Jurassic
M - Rundle & Banff - Mississippian
—— Exshaw - Upper Devonian
D - Upper Devonian, Undifferentiated
€ - Cambrian

Scale in miles



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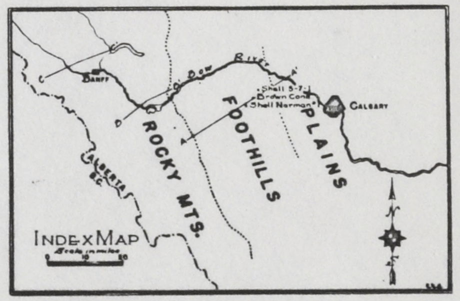

GEOLOGY OF TERRACES AT CHOCHRANE, ALBERTA. by A. MacS. STALKER.

(Canadian Journal of Earth Sciences, Vol.5 December 1968, p.1455.

Area underlain by Paskapoo formation (Tertiary), consisting largely of coarse to fine ss, commonly poorly indurated. Near river drift and alluvial, overburden is generally thin, bedrock outcrops are common.

Terraces consist of two groups, differing in compositon, origin and time of deposition.

I. The upper and older set lie north of Cochrane (Nos. 1,2,2a,3). } Are classical Wisconsin in age.

II. The lower set (Nos 4 to 8) lie mostly south of Cochrane.

Tharin (1960) on his map "Surficial Geology of the Calgary Area, Alberta" places all terraces in his "Morley Stratified Drift", generally coarse gravel.

I. Upper set of terraces was built as deltas by Bighill Creek where it flowed into pro glacial lakes, or as estuarine deposits. Bighill Ck was much larger, fed by glaciers and northerly streams diverted south along front ice sheet. Terraces consist of coarse gravel. Much of gravel stripped off by streams from p parts of Terrace 2, leaving only thin veneer over bevelled bedrock surface (T. 2a). These parts are 30' below original surface. Terrace 3 - gravel reaches thickness of 100', contains few stones from Shield brought by Laurentide glaciers.

Glacial lakes were ponded in front of Laurentide ice lying just to the east of Bow river valley. Shortly after construction of Terrace 2, that glacier advanced and raised lake level. As a result, Terrace 2 was buried beneath 50' of lake deposits. These were stripped from southern sections of the terrace, they remained on northern parts. They consist of 35' fine, stoneless sand, overlain by 15' dark grey or black clay grading upward into varved silt and clay, in turn covered by silt with included bands of gravel.

Terrace 1 may predate Terrace 2 and represent level of still earlier glacial lake, OR it may mark the level reached by lake that inundated Terrace 2. During retreat of Laurentide glacier, lake level was lowered, causing gravel and lake deposits to be stripped from much of Terrace 2 and allowing Terrace 3 to be formed. Further recession drained lakes, and ended deposition of upper series of terraces. Additional withdrawal of both Laurentide and Cordilleran glaciers resulted in an extended period of erosion by Bow river, which ended at about the time Bighill Ck formation started to form.

Terraces 1 & 2 were built towards time of maximum extent of Classical Wisconsin/Laurentide glacier, (when Laurentide ice stood close by;) between 19000 and 15000. Cochrane area is near extreme western limits of Laurentide glaciation. Burial of Terrace 2 indicates that glacier was still advancing slightly, but not sufficiently to overrun those terraces. Glacial lake reached elevation higher than 4000'; this approaches maximum height reached by Laurentide ice in the area during Classical Wisconsin time.

GEOLOGY OF TERRACES AT COCHRANE, ALBERTA. by A. MacS. STALKER.

(Canadian Journal of Earth Sciences, Vol.5 December 1968, p.1455).

Area underlain by Paskapoo formation (Tertiary), consisting largely of coarse to fine ss, commonly poorly indurated. Near river, drift and alluvial overburden is generally thin, bedrock outcrops are common.

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Valley fill formerly covered most of the valley at Cochrane to the height of T.4.

II. Lower Set of Terraces. (Nos 4 to 8). Cutting started ± 10,000 BP
Deposition " ±12-10,000 BP.

Formed by river action, 10,500 - 10,000 years ago, in the absence of ice and standing water, after prolonged glacier recession had caused Laurentide & Cordilleran ice sheets to withdraw far from Cochrane area.

Terrace 8 consists of the slip-off slopes and floodplain of modern Bow river.

Terrace 7 is minor terrace subsidiary to T.6.

Terrace 4 at about 3760' represents surface of valley fill that formerly occupied most of Bow river valley at Cochrane to that height.

The other terraces were carved from this valley fill - Bighill Creek formation - by Bow river after it had once again started degrading.

Terraces 4,5,6 & 7 are alike in composition, structure and surface slopes. They have remarkably flat-appearing surfaces that lower eastward 10-20'/mile. The scarps separating them typically slope at an angle of repose of material found in the terraces. Scarp between T.5 and T.6 stands so close to this angle that each year boulders loosened by frost tumble down. On T.5 and T.6 shallow channel, abandoned former course of Bow river, skirts much of base of surmounting scarp. Other small channels are found elsewhere on terrace surfaces. Bighill Creek formation consists of valley fill, taken from north bank Bow river.

Terrace 8 Bedrock overlain by a lag concentrate of boulders.

Terrace 6 & Terrace 7 20-25' coarse gravel over bedrock (exposed thickness of bedrock increasing downstream).

Terrace 4 & Terrace 5 See gravel pits on Clarke Terrace: Clarke Pit, Griffin South pit and Griffin North pit.

Clarke Pit - 35' deep west end; 20' deep NE end toward abandoned channel which is contact of T.4 and T.5.

Consists of gravel, sand, negligible amount of silt, clay below floor of pit. Ss, quartzite, ls, chert from Rocky Mnts.

Gravel is clean, well sorted, coarse, oval to spherical, generally subangular to subrounded, 1"-4", also 8" and boulders 3' long. Near bottomof pit large blocks 4'-5' long, rectangular, thin, little rounding. These were plucked by river from Paskapoo sandstone, probably moved by glacier (they do not display striation).

Sand: coarse to fine grit, clean, well sorted, in places contains scattered stones, mostly round and "armoured" mud balls. From R.M. & local Paskapoo formation.

2% Silt: 1"-3" thick, stones are rare. Marker beds indicating episodes of quiet water between deposition of marker beds.

Cordilleran Glacier: length nearly 1200 miles   main gathering: 55-59° lat.
breadth 400 miles   Reaches Arizona & Calif.

Ice was forced to discharge SW-ward toward Puget sound; toward Montana on the SE; and into Yukon valley toward NW through Stikine, Skeena & Fraser passes

Interior of Alaska & Yukon escaped glaciation – shielded by highest mountains of America from moist Pacific winds. (~~[illegible]~~).

Ice confined between Rockies & Coast Range reached thickness of 7000'-8000'. Evidence: striation, erratics, boulder clay. Lower part of ice was hemmed in between mountains, remained stagnant for thousands of yrs. Upper ice flowed over lower ice toward wide far outlets on SE & NW. (~~[illegible]~~).
Two glaciations, the 2nd one much milder with only valley glaciers, which did not form continuous ice sheet.

pitch
Rancho la Brea. 120 m N of San Pedro. Pitch beds.
Horses - Tapirs - Antelopes - Deer - Peccaries ~~Peccaries~~
Elephants - Ground sloths - Camels - Horses - Tapirs - Antelopes - Deer & mud turtle
Rabbits - Moles - Bats - >2000 Sabretooth Tigers - 3000 Dire Wolves & Toad.
Large amount of birds: Storks, SWALLOWS ~~swallows~~, eagle.

FIELD Vulcan DATE July 8, 1963 PAGE 5 OF 7.

WELL Cancrude Vulcan #10-20 STATUS ZONE

PURPOSE AND PROCEDURE To obtain bottom hole pressure build-up.

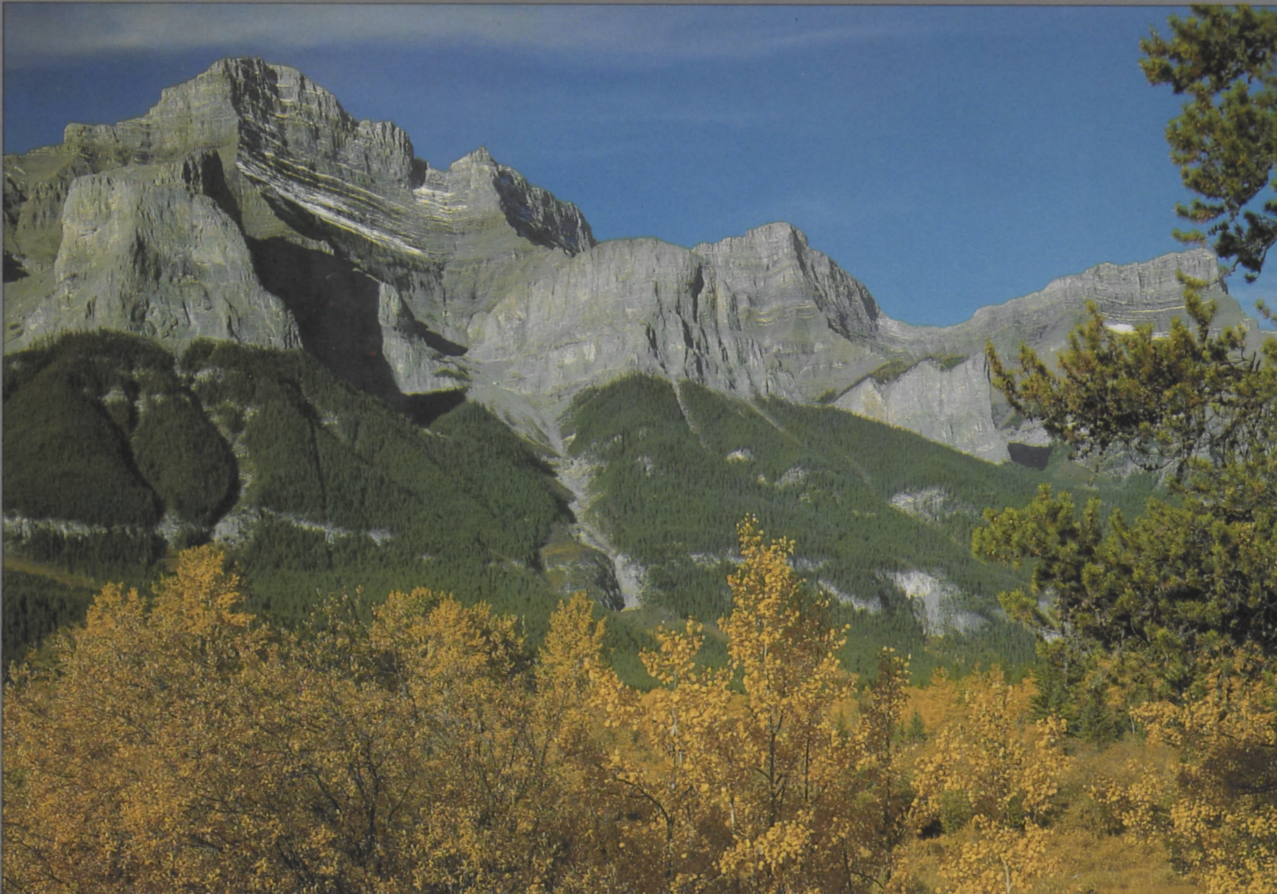
CALCULATIONS

DATE	DEPTH BELOW KB. CF. MV	TIME	DEFLECTION IN INCHES	PC PRESSURES psig	CORRECTION P-PC	CORRECTED PRESSURE psig	GRADIENT psig /ft.
July 9	5980	0048 Hrs.	1.1544	2394.8	-7.8	2387.0	
		0100 "	1.1546	2395.2	-7.8	2387.4	
		0112 "	1.1549	2395.8	-7.8	2388.0	
		0124 "	1.1552	2396.5	-7.8	2388.7	
		0136 "	1.1556	2397.3	-7.8	2389.5	
		0148 "	1.1559	2397.9	-7.8	2390.1	
		0200 "	1.1561	2398.4	-7.8	2390.6	
		0212 "	1.1563	2398.8	-7.8	2391.0	
		0224 "	1.1565	2399.2	-7.8	2391.4	
		0236 "	1.1567	2399.6	-7.8	2391.8	
		0248 "	1.1568	2399.8	-7.8	2392.0	
		0300 "	1.1579	2402.1	-7.9	2394.2	
		0312 "	1.1570	2400.2	-7.9	2392.3	
		0324 "	1.1571	2400.5	-7.9	2392.6	
		0336 "	1.1571	2400.5	-7.9	2392.6	
		0348 "	1.1572	2400.7	-7.9	2392.8	
		0400 "	1.1572	2400.7	-7.9	2392.8	
		0412 "	1.1573	2400.9	-7.9	2393.0	
		0424 "	1.1573	2400.9	-7.9	2393.0	
		0436 "	1.1574	2401.0	-7.9	2392.1	
		0448 "	1.1574	2401.0	-7.9	2392.1	
		0500 "	1.1575	2401.3	-7.9	2393.4	
		0530 "	1.1575	2401.3	-7.9	2393.4	
		0600 "	1.1576	2401.5	-7.9	2393.6	
		0630 "	1.1576	2401.5	-7.9	2393.6	
		0700 "	1.1577	2401.7	-7.9	2393.8	
		0730 "	1.1577	2401.7	-7.9	2393.8	
		0800 "	1.1578	2401.9	-7.9	2394.0	
		0830 "	1.1578	2401.9	-7.9	2394.0	
		0900 "	1.1579	2402.1	-7.9	2394.2	
		0930 "	1.1579	2402.1	-7.9	2394.2	
July 9	5980	1000 Hrs.	1.1580	2402.3	-7.9	2394.4	
		Filled lines at 1015 A.M. July 9, 1963.					
July 9	5980	1030 Hrs.	1.1558	2397.7	-7.8	2389.9	
July 9	5980	1100 Hrs.	1.1572	2400.7	-7.9	2392.8	
	Test #4 Flow started @ 1100 hours July 9, 1963.						
July 9	5980	1106 Hrs.	.9918	2053.5	-6.4	2047.1	
		1112 "	.9179	1898.4	-5.4	1893.0	
		1118 "	.8511	1758.2	-4.3	1753.9	
		1124 "	.8082	1668.1	-3.6	1664.5	
		1130 "	.7781	1604.9	-3.1	1601.8	
		1136 "	.7521	1550.4	-2.6	1547.8	
		1140 "	.7320	1508.2	-2.3	1505.9	
July 9	5980	1148 "	.7144	1471.2	-2.0	1469.2	

Cancrude Oil & Gas Co.
COMPANY

SUB-SURFACE PRESSURE SURVEY

Cancrude Vulcan #10-20-16-24
WELL NAME AND NUMBER



p. 96 D.M. Baird
Banff Nat'l Park

SCENIC PHOTO ART

TEL DON

Edition Teldon

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Mount Rundle, Banff National Park in the Canadian Rockies.
Mont Rundle, Parc National de Banff dans les Rocheuses canadiennes.
Rundle Berg, Banff National Park, Kanadische Rocky Mountains.
ロッキー山脈バンフ国立公園のランデル山
Photo: Siegfried Gursche

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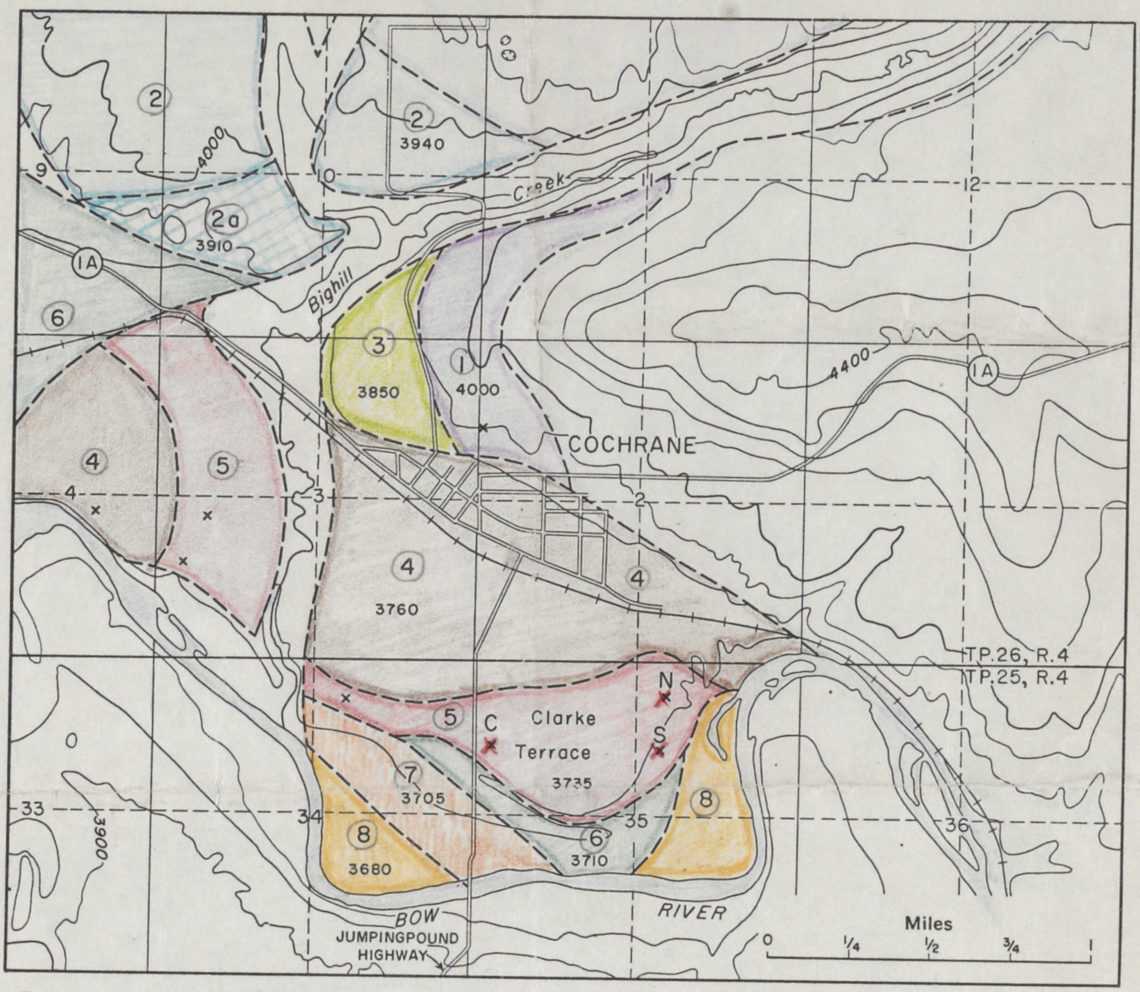


FIG. 2. Terraces north of Bow River at Cochrane, Alberta. The terrace numbers and elevations are as shown in Table I. x = gravel pit, C = Clarke Pit, N = Griffin North Pit, S = Griffin South Pit. Contour interval 100 ft.

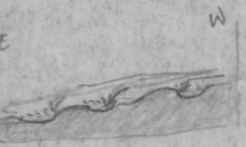
Fig. 2, numbers 1, 2, 3) were built as deltas by Bighill Creek where it flowed into glacial lakes, or as estuarine deposits along its lower segment. At that time the creek was much larger than at present, for it was fed by vast quantities of glacier meltwater. It also received the discharge of more northerly streams that had been diverted south along the front of the ice-sheet. The terraces consist mostly of coarse gravel. Much of the gravel has been stripped by streams from parts of terrace 2, leaving only a thin veneer over a bevelled bedrock surface (Fig. 2, terrace 2a). Those parts are now about 30 ft below the original surface. The gravel in terrace 3 reaches a thickness of nearly 100 ft. It contains a few stones brought from the Canadian Shield by glaciers; these indicate that Laurentide ice was nearby when the terrace was built. Careful examination probably would reveal such stones in the other terraces also.

The glacial lakes were ponded in front of Laurentide ice lying just to the east in Bow River Valley. Apparently, shortly after construction of terrace 2, that glacier advanced and raised the lake level. As a result, terrace 2 was buried beneath some 50 ft of lake deposits. These subsequently were stripped from southern sections of the terrace, but remain on northern parts. They consist of 35 ft of fine, stoneless sand overlain by a 15-ft sequence of dark gray or black clay grading upward into varved silt and clay, in turn covered by silt with included bands of

Deposition. Bighill Creek formation reveals turbulent and constantly shifting course; bedding extremely variable, cross- and channel bedded. Dips vary greatly.

Valley fill composing Bighill Creek formation was laid down as Bow river raised its bed. No major hiatus, nor erosion. The sand of the Clarke Pit member is the only indication of major change in type of deposition, which was temporary and river soon reverted to its former pattern.

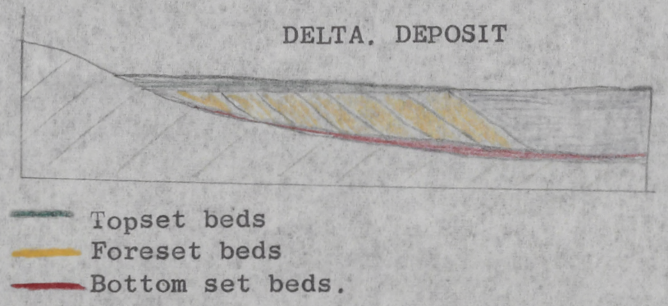
At Cochrane the Bh Ck fn is composed of nearly horizontal units, generally 2'-8' thick (Clarke Pit member is one of the units), in sharp contact with each other, in many places separated by thin silt or fine sand beds. Some units are characterized by steeply dipping foreset beds that cut most of the way across them. These foreset beds indicate deposition from westerly direction (as would be expected). They were built by fast-flowing river, heavily-laden, that dropped most of its load rapidly at a place where its current decreased. This raised river bed sufficiently at that point to enable river to carry more of its load farther downstream. This was a continuous process, with the point of maximum current slackening and deposition progressing steadily downstream (eastward), and in that manner building one of the units of the Bh Ck fn.

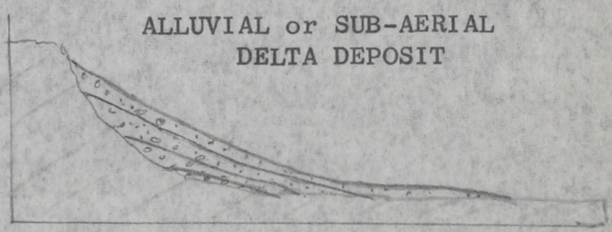


This process resembles construction of typical deltas, built into standing water; ~~for~~ however, there is no indication of ponding at that time. If foreset beds were merely local feature of the formation, they probably resulted from a widening of Bow river valley at that spot, with consequent slackening of river current.

Each unit forming Bh Ck fn started with river currents carrying coarse gravel. Enough gravel laid down to raise river grade several feet. Thereafter slack water prevailed over flood plain for a time, perhaps while the main channel of river passed elsewhere in valley and coarse gravel was deposited farther up or down stream. Thin beds of silt and fine sand were spread during such periods of locally quiet, generally shallow water. Then the sequence was repeated and river grade further raised. This process continued until the fill reached the level of terrace 4, or a thickness of 70'. During all that time the river was oscillating and eroding or depositing locally, causing heterogenities in deposits and forming channel and cross beds.

Anastomosing = braiding (river).





After spring and early summer runoff has subsided, gravel and sand bars become exposed. Water spills over these shoals, depositing silt and sand in the lee of the shoals, but little or no gravel.

The thick sand in the NE part of Clarke pit was laid down under such circumstances, while main river channel lay farther south. The sand of Clarke Pit member is result of process continuing for abnormally long time. An important consequence was that bones were buried in the sand and preserved.

Bones could not have been carried far in turbulent water without being pounded by stones. Being light they could be carried over bars into the slack water behind, on the lee of the bars. Bones of animals that had died on the spot are only scattered to a small extent. Bones were covered with sands, the sands subsequently covered by gravel.

At the beginning of the final episode, conditions changed - through change either in discharge, load or gradient, to start river downcutting. It carved the lower set of terraces and while so doing, swung continually farther south, away from the earlier terraces.

<u>Age.</u> Bow river started to carve lower set of Terraces an estimated 10,500 - 10,000 years BP, and process has continued to present time.

Upper set of Terraces estimated to have formed between 19,000 and 15,000 years BP.

The estimate of when the lower set started to form is based on assumption that river did not start carving the terraces until deposition of Bh Ck fn was completed. Bh Ck fn was laid down long after the maximum of Wisconsin glaciation, when both Cordilleran and Laurentide ice had receded far from the scene. On the other hand, the formation has existed sufficiently long to let Bow river incise through it into underlying bedrock. Its deposition took place towards the close of the Wisconsin Glacial. This estimate of its age is substantiated by 3 radiocarbon dates and vertebrate fossils.

Bones collected from Clarke Pit member: 10,760 (±160) years BP from Griffin pit; 11,370 yrs BP from Clarke pit; 11,100 (±160) yrs BP from Clarke pit. Clarke Pit member laid down ± 11,000 yrs BP.

Extent of ice advance on Great Plains during deposition of Bh Ck fn is practically unknown. Christiansen (1965) showed ice front as then lying in western Sask., extending northward. Ice advance was extensive on the plains during that time, and this, combined with changed climate which caused that readvance, had major consequences for fauna, flora and drainage.

Correlation of Rocky Mountain ~~area~~ sequence with glacia~~l~~tion sequences elsewhere in North America is difficult. According to Richmond (1965, p.227) at 11,000 BP the interstade between middle and late Pinedale glaciation was near its mid-point.

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The last significant Wisconsin advance, the late Pinedale stade, did not advance until 10,000 BP. However, circumstances in Cochrane region could have differed markedly from the regions farther south, those reviewed by Richmond.

Fossils gathered from Clarke Pit member include two extinct animals: Mexican ass (Equus conversidens) and Western bison (Bison B occidentalis). Both were prevalent 11,000 BP, but they were extinct by the climatic optimum of 5500-6000 yrs BP. Mex. ass fossils suggests fairly warm climate. There were only two extended warm periods in the region during postglacial time. The last one can be eliminated, as Mex.ass and western bison were extinct. The earlier warm spell, perhaps corresponding to the Two Creeks Interstade farther east, appears to have been the time when Mex.ass was abundant in the Cochrane area. Once established it could have survived in large numbers until climate deteriorated and Bh Ck fn was deposited.

Radiocarbon dates only apply to Clarke Pit member and not to how long it took to deposit Bh Ck fn. 30' of formation lie above member and another 35' below. Rate of deposition must have varied, but no pauses nor episodes of erosion are indicated.

Bighill Creek formation was probably constructed between 12,000 and 10,000 yrs BP, mainly between 11,500 and 10,500 yrs BP.

Postglacial Bow river, following deposition of upper set of beds, degraded its valley, then raised bed to build lower set (Bh Ck fn), next cut down to present grade, and still continues to lower its bed.

Material in lower set of terraces was carried into the area and deposited by Bow river, but why river did so following retreat of Laurentide ice has not been determined satisfactorily. Probable causes:

1. Tilting of land surface.
2. Local obstruction or damming of river.
3. Ice-advance or retreat.
4. Change in discharge down Bow and Kananaskis valleys.

(2.) can be eliminated, for terraces continue for considerable distance up and down valley from Cochrane and top of valley fill (surface of Terrace 4) has a slope similar to gradient of present Bow river. Local obstruction (damming) would give a more horizontally topped deposit or delta, containing more fine material than present.

(1) Little is known about postglacial tilting on western prairies. No indications of rapid tectonic movements - such as faults. Various ice sheets were much thicker on eastern prairies than on western, due to general eastward lowering of the land surface. Rebound was greater in the east. Much of this rebound should have taken place before deposition of Bh Ck fn, for by that time the ice had melted from most of the prairie region and had become much thinner in remaining regions.

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place before deposition of Bh Ck fm, for by that time the ice had melted from m
of the prairie region and had become much thinner in remaining regions.

In addition, the ice advance of 12,000 to 11,000 yrs BP probably slowed down or terminated uplift on eastern prairies. It is difficult to conceive how rebound, relatively so much greater on the eastern prairies, could have caused Bow river to aggrade sufficiently to deposit 70' of alluvium and then resume down cutting.

(3) & (4) Major rejuvenation of glacier, which took place around the time Bh Ck fn was laid down, had catastrophic effect on drainage in front. It diverted rivers, ponded large pro-glacial lakes and raised base levels of nearby rivers by several hundred feet. Cochrane is some 250 miles west of suggested limit of advance. Changes near the front were so immense that some effect may have been felt even that far off as river raised its grade westward. However, any such effect was minor and insufficient to cause deposition of Bh Ck fn.

In local area some advance of Cordilleran ice may have taken place. Position of Crowfoot glacier at that time is now known, but certainly it was far west of Morley. In Kananaskis valley, any glacier advance stopped above confluence of Kananaskis and Bow rivers.

Movements of mountain glaciers affected Cochrane area by changing flow and load of Bow river and its tributary, the Kan. river, and also the interval between ice front and Cochrane. Isostatic effect and influence on river gradient were negligible. Change in distance of transport has an influence. Advance would decrease flow by storing water as ice, but decrease the distance and so enable river to carry more and coarser material to Cochrane. Retreat would augment normal stream flow and supply of material by releasing water and debris, but would also necessitate farther transport of debris. Also under retreatal conditions, material deposited at Cochrane should become finer upward as the source receded, but the reverse seems to be the case.

Advance or retreat in the mountains is transitory and could hardly have continued to affect Cochrane area for the one or two thousand years needed for deposition of the Bh Ck fn.

Stable ice front upvalley: if stabilized after retreat, conditions would have resembled those at present with the river downcutting.
If stabilized after significant advance, decreased run-off in winter, but larger and steadier run-off in summer. Decreased distance to Cochrane would have enabled river to carry more coarse material to the area. The topmost part of the Bh Ck fn, with its somewhat coarser material, may represent early stages of glacier recession, when increased discharge over much the same distance could have caused slight coarsening in material deposited.

It appears therefore that the most likely cause for the deposition of the Bh Ck fn was a significant ice-advance down Bow and Kananaskis valleys, followed by near stabilization of glaciers at their forward positions. This hypothesis is put forward in full knowledge that the time in question is supposed to represent an interstade in mountain glaciation.

Scattered fossil bones were found in drainage ditches dug across T.6 and T.7. More may be found if gravel pits were opened there, and beneath most of T.4 (on which the town of Cochrane is situated) 30'-35' deep (continuation of Clarke Pit member).

Upper set of terraces contains few, if any fossil bones, because these terraces were laid down under inhospitable conditions in frigid proglacial lakes by meltwater streams coming from the ice.

The bones were probably buried during a time of marked glacier expansion. They represent a fauna that had spread into the area during the preceding interstade. The occurance of Mex. ass in large numbers, with complete absence of wood, indicates that the climate was warm, perhaps similar to the present or slightly warmer.

Mr. George L Clarke and Mr. Charles Clarke. Mr E.N. Griffin.
owners of gravel pits.

Christiansen, E.A. (1965) Ice frontal positions in Sask. (Sask. Res.Council, Geol.Div Map No.2.

Tharin, J.C. (1960) Glacial Geology of Calgary, Alberta, Area. (133 pp). Unpublished Ph.D. thesis. Geol.Dept. U.of Illinois, Urbana, Ill.

C.S. Churcher "Pleistocene Ungulates from the Bow river gravels at Cochrane, Alberta".

Cervus Canadensis (Wapiti)
Rangifer Tarandus (Caribou)
Ovis Canadensis (Mountain Sheep)
Bison occidentalis (Western Bison, extinct)
Equus conversidens (Mexican Ass, extinct)

(This article appeared in Canadian Journal of Earth Sciences, Vol.5, December 1968).

TABLE I

Terraces north of Bow River at Cochrane, Alberta. Except perhaps for terraces 1 and 2, the higher terraces are older than the lower ones. River low-water level is assumed to be 3670 ft above sea level at Jumpingpound highway crossing.

Reference number	Approximate height (in ft) above sea level	Bow River	next terrace	Composition	Origin	Remarks
			Upper Set of Terraces			
1	4000	330	60	largely unknown; medium to coarse gravel (?)	deposit of Bighill Creek into glacial lake	site of Cochrane 'Retreat', may be younger than terrace 2
2	3940	270	30	gravel over bevelled bedrock surface	deposit of Bighill Creek into glacial lake	northern part buried under glacial lake deposits
2a	3910	240	60	thin gravel veneer over bedrock surface	stripping of gravel from terrace 2	subsidiary of terrace 2
3	3850	180	90	medium to coarse gravel	delta built by Bighill Creek into glacial lake	site of High School; flat surface
			Lower Set of Terraces			
4	3760	90	25	coarse gravel	surface of valley fill	site of town of Cochrane
5	3735	65	25	sand to coarse gravel	erosion by Bow River	Clarke Terrace; site of Clarke, Griffin, and other gravel pits
6	3710	40	5	medium to coarse gravel	erosion by Bow River	contains several small gravel pits
7	3705	35	25	medium to coarse gravel	erosion by Bow River	subsidiary to terrace 6
8	3680	10	—	bedrock with veneer of lag gravel	erosion by Bow River	includes modern floodplain and slip-off slopes

river aggradation, and undoubtedly it can be traced extensively along other river valleys on the plains to the east, as well as farther upstream and downstream along Bow River. At Cochrane it is 70 ft thick.

Clarke Pit Member

The name "Clarke Pit Member" of Bighill Creek Formation is here proposed for the beds that produced most of the vertebrate fossils. The type section also is at the A. W. Clarke and Sons gravel pit, where the member is 5 to 8 ft below the terrace surface. There it consists predominantly of sand and grit, and has sharp, horizontal contacts with the overlying and underlying coarse gravels. The member is described in more detail later.

Clarke Terrace

Clarke Terrace is used here for the terrace containing Clarke and Griffin gravel pits. It is terrace number 5 in Table I and Fig. 2, and is the one immediately below the terrace on which Cochrane townsite is situated. Named for the family that has long owned the property, it encompasses about 240 acres of NE.$\frac{1}{4}$ Sec. 34 and N.$\frac{1}{2}$ Sec. 35; Tp. 25, Rge. 4, W. 5th Mer. At Clarke gravel pit it is 3735 ft above sea level and 65 ft above the level of Bow River at Jumpingpound highway bridge. Terrace 4 surmounts it by 25 ft; terrace 6 lies 25 ft lower.

Griffin South and North Pits

For convenience, the two gravel pits of Mr. E. N. Griffin are here designated Griffin South and Griffin North. The former lies in Lsd. 10, the latter in Lsd. 15, of Sec. 35, Tp. 25, Rge. 4, W. 5th Mer. (*see* Fig. 2).

Upper Set of Terraces

The upper terraces at Cochrane (Table I and

preserved with a minimum of further damage. Bones of some animals that had died on the spot were scattered to only a small extent; those of some animals that grounded on the bars were buried when sand deposits overlapped onto those bars. The sands subsequently were covered with gravel and thus shielded from further erosion. The result was the abundance of vertebrate fossils we find to-day in the Clarke Pit Member.

The beginning of the final episode saw conditions alter sufficiently—through change either in discharge, load, or gradient—to start the river downcutting. In the Cochrane area it then carved the lower set of terraces and, while so doing, swung continually farther south away from the earlier terraces and thus effected their preservation.

Age

Bow River started to carve the lower set of terraces at Cochrane an estimated 10 500 to 10 000 years ago, and the process has continued to the present time. In contrast, the upper set was estimated earlier to have formed between 19 000 and 15 000 years before present. The estimate of when the lower set started to form is based on the surmise that the river did not start carving the terraces until deposition of Bighill Creek Formation was completed, and that the terraces must postdate that formation.

Bighill Creek Formation was laid down long after the maximum of Wisconsin glaciation, when both Cordilleran and Laurentide ice had receded far from the scene. On the other hand, the formation has existed sufficiently long to let Bow River incise through it into underlying bedrock. Its deposition apparently took place towards the close of the Wisconsin Glacial. This estimate of its age is substantiated by the small amount of direct evidence we have, which consists of three radiocarbon dates and the vertebrate fossils.

All three radiocarbon dates are on bone collected mostly from the Clarke Pit Member. GSC-612 (10 760 $\pm$ 160 B.P.) came from the Griffin pits, and GSC-613 (11 370 B.P.) from Clarke pit (Lowdon *et al.* 1967, pp. 14, 15). GSC-989 (11 100 $\pm$ 160; previously unpublished) also came from the Clarke pit. The sample from the Griffin pits should be younger than those from the Clarke pit, for it came from somewhat higher stratigraphically in the deposit. Its chief source was the grit beds forming the top part of the member there, whereas the samples from the Clarke pit came chiefly from the main sand bed of the member. Nevertheless, the age difference is greater than expected and additional samples are being dated in an effort to resolve this discrepancy. Until such new dates are available we can only assume that the Clarke Pit Member was laid down about 11 000 years ago.

The extent of ice advance on the Great Plains during deposition of Bighill Creek Formation is practically unknown. At the latitude of Cochrane, Christiansen (1965) showed the ice-front as then lying in western Saskatchewan. Undoubtedly the front was a short distance east of the Alberta border at that latitude, and thence ran northwestward. Certainly ice advance was extensive on the plains during that time and this, combined with the changed climate that caused that readvance, had major consequences for fauna, flora, and drainage.[1]

Correlation of events near Cochrane with glacial sequences elsewhere is uncertain. Farther east in North America, in Wisconsin, Valders ice-advance buried the Two Creeks forest bed 11 850 years ago (Broecker and Farrand 1963, p. 796), and reached its maximum extent an estimated 11 500 to 11 300 years B.P. It would appear that the Clarke Pit Member was deposited some 800 years after the Two Creeks forest bed had been overrun, and 300 to 500 years after Valders ice-advance had reached its peak, but still during Valders time. In Wisconsin and Michigan, at the time of deposition of Clarke Pit Member 11 000 years ago, Valders ice was in

[1]A strong ice advance some 12 000 to 11 000 years ago, with consequent proglacial ponding and raising of stream grades, helps to explain certain puzzling radiocarbon dates from the southwestern prairies. Thus, a buried soil outcropping on the bank of St. Mary River in the Blood Indian Reserve in south-central Alberta gave a date of 10 620 $\pm$ 250 years B.P. (GSC-161; Dyck and Fyles 1964). This soil had formed on a thick sequence of varved silt and clay, and was buried by stream and wind deposits. It also lies far above the level of the present St. Mary River. It appears that the river flowed at that high level some 11 000 to 10 000 years ago, a phenomenon that could have occurred only if drainage was obstructed farther east. Similarly, dates of 10 500 $\pm$ 200 years B. P. (GSC-3; Dyck and Fyles 1963) and 11 000 $\pm$ 250 years B.P. (S-68; McCallum and Dyck 1960, p. 75) were obtained from fill in a former channel of Oldman River, also high above its present valley. That channel was in use when the main valley was blocked farther east, either by local ice-jams or by an ice-sheet. In addition, thick lake silts covering a broad area near the confluence of South Saskatchewan and Red Deer Rivers, at Empress in eastern Alberta, probably date from the same time. They are found in a valley that had been incised, during earlier ice retreat, to far below the present grade of Red Deer River. The silts were laid down when obstruction of the river farther east caused widespread ponding in that area. The coarse material, on the other hand, was dropped farther upvalley, and forms the thick fill found beneath the present channel of Red Deer River westward to beyond Steveville. In all places described the rivers had incised deeply before laying down the deposits. A long episode of marked ice retreat, perhaps corresponding to the Two Creeks Interstade, plainly had preceded the strong advance of 12 000 to 11 000 years ago.

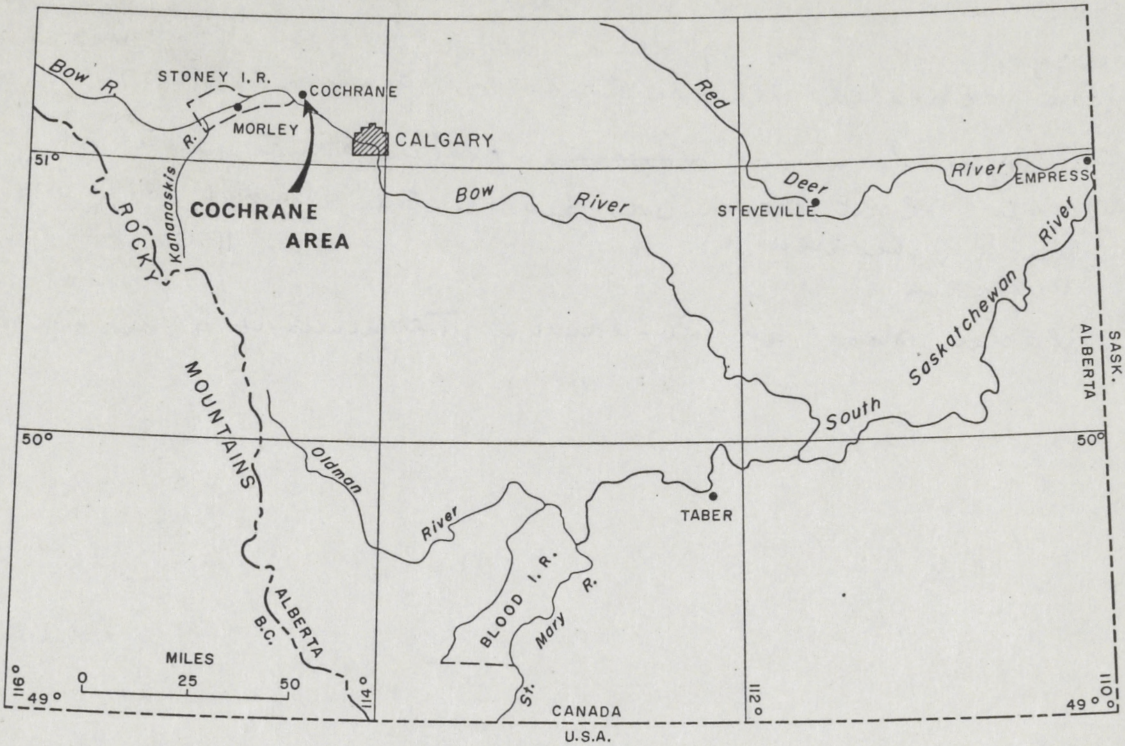

FIG. 1. Southern Alberta, showing towns and features referred to in text.

upper and older set (Table I, numbers 1, 2, 2a, 3; Fig. 2, numbers 1, 2, 2a, 3) lies north of Cochrane in NE.$\frac{1}{4}$ Sec. 3 and in Sec. 10, Tp. 26, Rge. 4, W. 5th Mer. The lower set, which includes terraces 4 to 8 of Table I and Fig. 2, lies mostly south of town. Because terrace 5 yielded the bones, we are concerned chiefly with this lower set, and especially that part of it extending from the bluff at the north edge of Cochrane southward to Bow River, and from Bighill Creek eastward to the first meander of Bow River (approximate latitudes 51° 10′ 25″ to 51° 11′ 40″ N.; longitudes 114° 26′ 40″ to 114° 29′ 00″ W.). This area encompasses the northeastern part of Sec. 34 and most of Sec. 35, in Tp. 25, Rge. 4, W. 5th Mer., and the southwestern part of Sec. 2 and southeastern part of Sec. 3, in Tp. 26, Rge. 4, W. 5th Mer. The lower terraces also extend farther west, mostly along the river's north bank. Directly downstream they are confined chiefly to the south side, and are less prominent.

Nomenclature

Tharin (1960) on his map "Surficial Geology of the Calgary Area, Alberta" placed all of the terraces at Cochrane in his "Morley Stratified Drift: prominent, often as valley train. Generally coarse gravel." "Morley Stratified Drift" is used solely on his map, and so is not defined.

Bighill Creek Formation

In this paper, the terraces at Cochrane are divided into an upper set and a lower set (*see* Table I). The two sets differ in composition, origin, and time of deposition. The name "Bighill Creek Formation" is proposed for the sediments composing the lower set of terraces, or those at or below the level of Cochrane. The formation is named after Bighill Creek, which crosses the lower set of terraces just west of the town (*see* Fig. 2). The type section is the A. W. Clarke and Sons gravel pit in NW.$\frac{1}{4}$ Sec. 35, Tp. 25, Rge. 4, W. 5th Mer., which is excavated entirely in this formation and exposes a section through most of it. Similar sections are revealed at the E. N. Griffin gravel pits in NE.$\frac{1}{4}$ Sec. 35, Tp. 25, Rge. 4, W. 5th Mer. Composition of the formation is described later. Bighill Creek Formation was deposited during an episode of

Wood from sand between Floral and Battleford formations was radiocarbon dated at more than 34,000 yrs BP. This date suggests that the glacier depositing the Floral formation had retreated from the Saskatoon area more than 34,000 years ago.

Battleford formation ~~advanced~~ glacier advanced about 20,000 years ago.
Prince Albert region was deglaciated about 11,560 (± 640) BP.
Quill Lake area " " " 11,000 (±150) BP.
Marsden " " " " 15,000 BP.
Glacier stood at Re-advance Terminus 4 about 13,000 BP.


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BANFF NATIONAL PARK
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The wind-surfer on Vermilion Lakes has added a new dimension to the many activities in the Banff area.

Mount Rundle serenely overlooks the Banff townsite and the Bow and Spray River Valleys.

Photo by J. W. Jones Sales Ltd.

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THREE SISTERS MOUNTAIN

The Three Sisters Mountain 9750' (2972 m) just east of Banff National Park overlooking the Bow River and the town of Canmore, Alberta.

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For Deborah and Sidney.

Aug. /84

The Province of Alberta has been an inland sea for most of its geological past. Sediments from ancient mountain ranges to the east and west were carried into the sea basin and the weight of these sediments depressed the bottom of this basin (called a geosyncline).

When you look at a cross section covering the three prairie provinces, you will see that the formations are dipping to the west and that the older formations (Cambrian, Ordovician, Silurian) which are lying on or close to the surface in Manitoba, are covered with thousands of feet of sediments in Western Alberta.

This inland sea has had an ever changing shore line: sometimes the water receded or the land was uplifted. When land is above water, it is subject to erosion and, of course, there is no deposition. Therefore you will find various gaps in the stratigraphic column in different areas in the province.

Sediment layers are laid down horizontally and in the correct sequence, i.e. oldest on the bottom and most recent on top and if this is not the case, something drastic has occurred, like mountain building (orogenesis).

With the presently accepted theory of plate tectonics, mountains are formed when two plates collide. The pressure from the west has been exerted on the tens of thousands of feet of sediments which, under their own pressure and heat had changed into rock (various types of rock).

You can see this pressure from the west in the mountains of the front ranges. They all show a westward dipping slope and a steep east face. These rocks have been tortured, for there was 30,000' depth and not enough space to spread out, therefore folded and faulted they were pushed up and over younger formations.

At the end of the Cretaceous Period, 70 Million years ago, this something drastic started and the last of the dinosaurs must have witnessed the beginning of it - and we and the bears are still witnessing it, for the pressure and hence the uplift has not stopped.

In the mountains you can detect folds:  consisting of  = Anticline (I always have to think of the letter A), and its opposite:  = Syncline.

A fault is where the rock broke and part of it slid up or down, the layers do not fit together anymore.

A well known fault is the McConnell Thrust Fault running north from Montana far into Alberta, where older rocks have been pushed on top of younger ones. An example is Yamnuska. This huge tooth-shaped rock of Cambrian age has been thrust on top of rocks of Cretaceous age - a difference of 300 MM years. It happened like this:

Then erosion (glaciers, frost, rain, wind) removed most of the top layers.

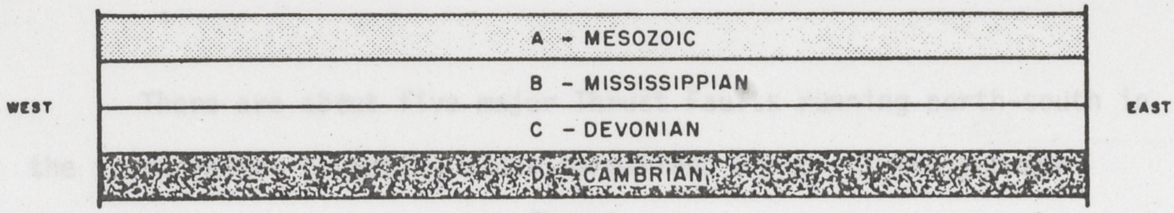


Figure I

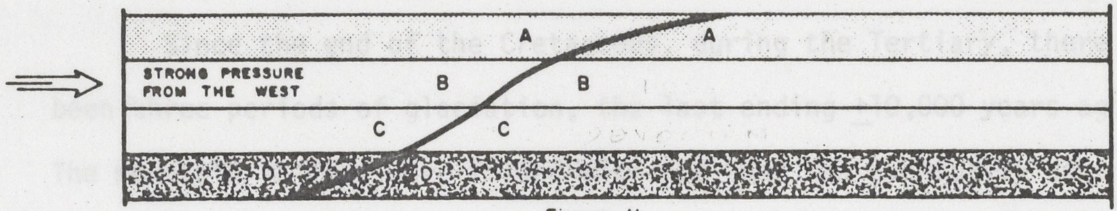


Figure II

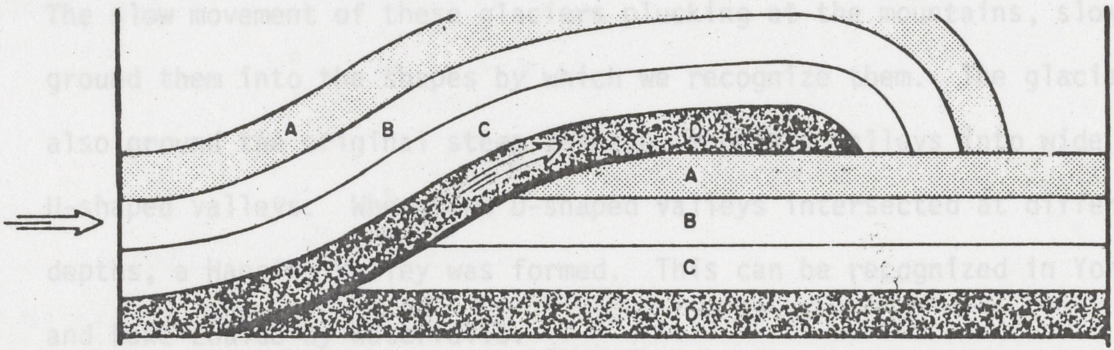


Figure III

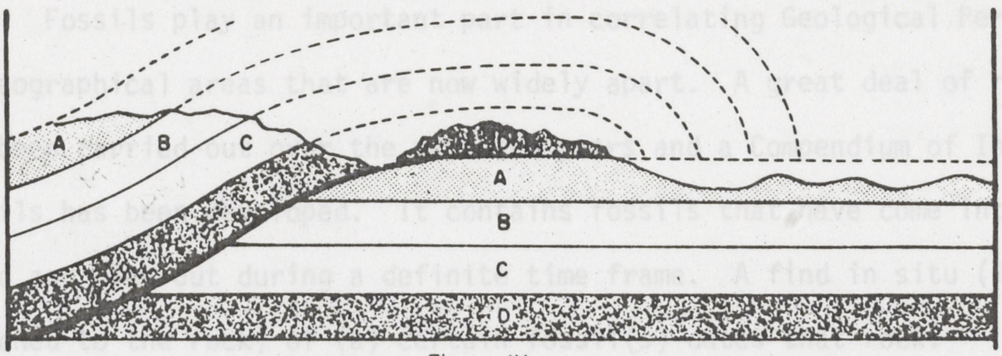
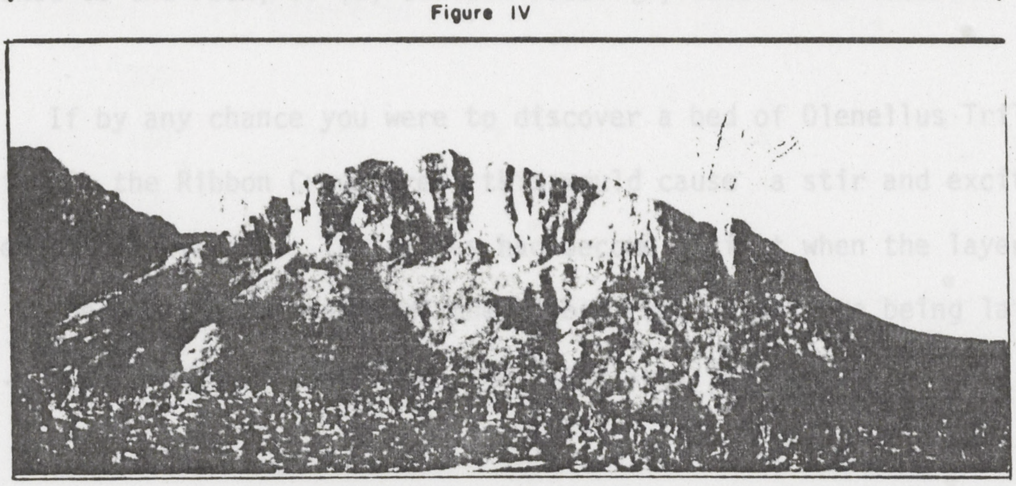


Figure IV



MOUNT YAMNUSKA

Stop Number 3

Fig. 2

There are about five major Thrust Faults running north-south in the front ranges thrusting older formations on top of the younger formations.

Since the end of the Cretaceous, during the Tertiary, there have been three periods of glaciation, the last ending ±10,000 years ago. The mountain valleys were filled with ice that was eventually deep enough to cover all but the highest peaks, i.e. Assiniboine or Temple. The slow movement of these glaciers plucking at the mountains, slowly ground them into the shapes by which we recognize them. The glaciers also ground the original steep V-shaped mountain valleys into wide U-shaped valleys. Where two U-shaped valleys intersected at different depths, a Hanging Valley was formed. This can be recognized in Yoho and Lake Louise by waterfalls.

Fossils play an important part in correlating Geological Periods in geographical areas that are now widely apart. A great deal of research has been carried out over the past 100 years and a Compendium of Index Fossils has been developed. It contains fossils that have come into being, lived and died out during a definite time frame. A find in situ (in place, attached to the rock) of (a) certain fossil(s) dates that rock.

If by any chance you were to discover a bed of Olenellus Trilobite fossils in the Ribbon Creek area, this would cause a stir and excitement in geological circles. Trilobites had become extinct when the layers that were to become the mountains of the Ribbon Creek area were being laid down. All the same, should you find Olenellus, let me know.

Happy Hiking and Hunting!

PERIOD in MM of years since it began		Formation	ERA
QUARTERNARY	1		CENOZOIC 1 - 70 MM years ago
TERTIARY	70	Paskapoo	
CRETACEOUS	125		MESOZOIC 70 - 200 MM years ago
Upper "		Edmonton Bearpaw Belly River Wapiabi Cardium Blackstone	
Lower "		Blairmore	
L.C. & Jurassic		Kootenay	
JURASSIC	165	Fernie	
TRIASSIC	200	Spray River	
PERMIAN	230)	Rocky Mountain	PALEOZOIC 200 - 500 MM years ago
PENNSYLVANIAN	260)		
MISSISSIPPIAN	290	Rundle Banff	
DEVONIAN	330	Palliser Fairholme	
SILURIAN	360		
ORDOVICIAN	420		
CAMBRIAN	500		
PRE-CAMBRIAN	5000±		ARCHAEOZOIC 500 - ±5000 MM years ago

THE HERALD Magazine

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CALGARY, ALBERTA, FRIDAY, FEBRUARY 26, 1971

Junior Achievers

The many and varied products on the table at left — from cleaning solutions to cigarette lighters — were all made by the young business men and women of the Calgary Junior Achievement association. The two young achievers at left are Greg Last, a student from Central Memorial and a member of the JA Finamopus organization sponsored by Canadian Fina; and Susan Haigh, a Sir Winston Churchill student in the BDN organization sponsored by Husky Oil. Herb Brennen, executive director of JA in the city, is the man in the middle; Mr. Brennen is also the subject of this week's personality profile on Page 4. Herald photo by Bill Simpkins.

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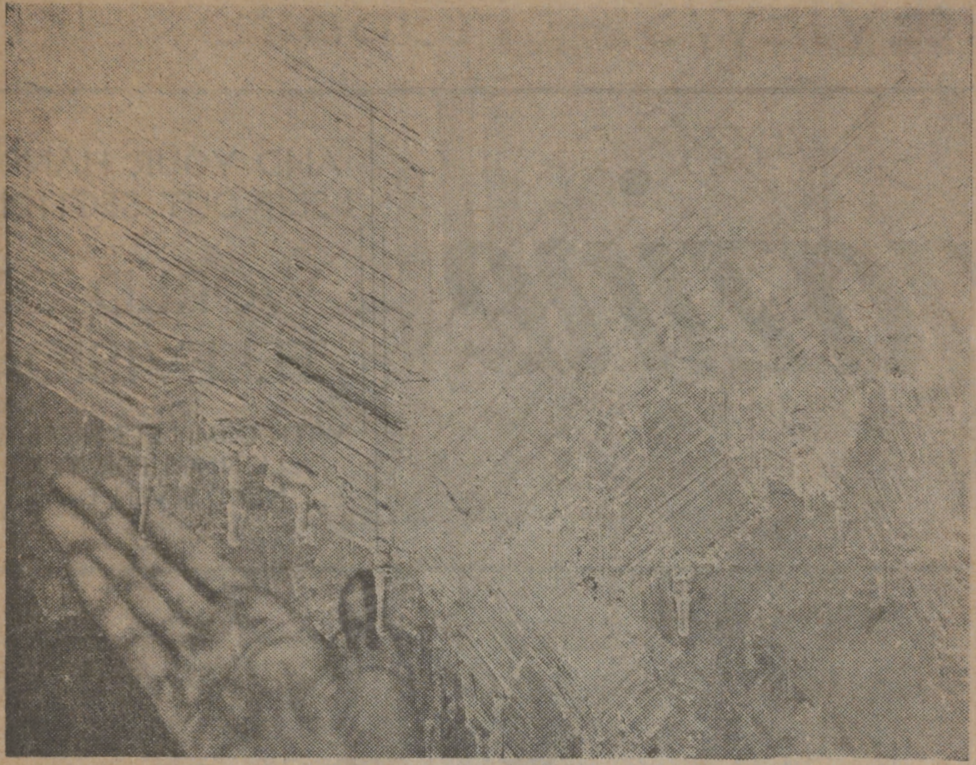
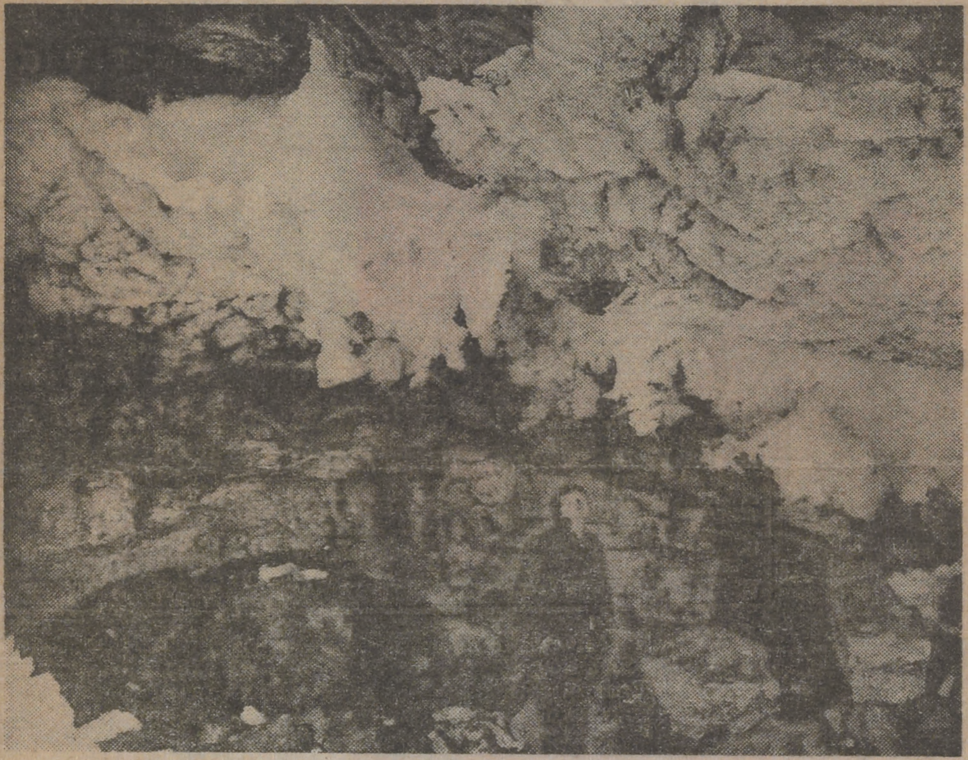


A THIN, FRAGILE PLATE OF GLASS
.. *part of a formation in an unusual southern Alberta cave*



CAVE HAS A VARIETY OF ICE FORMATIONS
... *from delicate plate ice to solid masses of ice*

(Photos on this page by James B. Posey)

ICE CLINGS TO CAVE WALLS
... *flowstone rock in centre is red*

Speliologists are mountain climbers who do their climbing inside mountains

Some of Mother Nature's most fascinating displays can be found hidden away in the caves of Alberta

By Don Thomas
(Herald Staff Writer)

A thin pencil of light from the cave-hunter's helmet lamp barely shows the way over a mass of rubble at the cavern entrance. Dull brown walls blot up the light as the cave-hunter rounds a corner. Then the beam stabs up, and suddenly shatters into a million fragments, glinting off masses of ice.

Row upon row of huge knife-edge crystals cling to the walls and roof as thickly as barnacles on a sea boulder.

Many are thin, fragile plates veined like a leaf. No one really knows how long they have been growing there — guesses range from perhaps 100 to several hundred years.

But some are up to 24 inches across. Cave experts have never heard of crystals that large anywhere else in the world.

There are other ice shapes: delicate celery stalks of ice forced at great pressure from hair-line cracks in the cavern roof; pebble-sized diamonds crusting over the rock like stucco; familiar-looking icicles and solid masses of ice.

The formations are in a cave located in southern Alberta.

No other cave in Canada is known to have ice structures so extensive or so varied.

Three years ago, when visited by a team under Dr. Derek Ford of McMaster University at Hamilton, Ont., the cave was rarely entered and still is in a "pristine" state.

Since then it has "deteriorated sadly" because of frequent visitors in the summer months. An estimated 30 per cent of the ice structures have melted and experts are fearful that unless casual visits are controlled the ice cave may be wiped out.

Already huge chunks of ice have crashed down to the cave floor. Bits of broken crystals crunch underfoot like bits of shattered glass. Tiny icicles droop down from the large plate-like crystals.

Critical factor is the inside temperature of the cave and the extra heat brought in by visitors and the lamps, flashbulbs and even gasoline lanterns they sometimes carry.

Thermometers placed by University of Alberta scientists show the temperature hovers around 31 degrees. Yet increases of up to two degrees were recorded on weekends last summer as visitors pressed into the cave.

Some crystals appear to be growing as water vapor in the humid cave changes directly into ice on the surface of the crystals.

But in the past few years rate of growth in spring and fall has been exceeded by melting in summer and apparently the cave is doomed.

Various ideas have been tossed around to save it. Dr. Ford's cave study team even debated the merits of refrigerating the cave before discarding the idea as too costly.

He has also drawn up plans for an entrance gate and presented his plans to members of the Alberta Research Council. But nothing has materialized.

Members of the Alberta Forest Service in Edmonton are aware of the cave and the disaster facing it. A reserve has apparently been placed on the area, but it offers little real protection.

Best protection may require somehow sealing up the cave as a time capsule for the future.

Here is the wrenching dilemma of the responsible "caver" who first ventures into such a place with his ropes and carbide lamp and is dazzled by the artistry of nature's slow, precise hand.

If you try to preserve such a treasure through governmental action you may yet destroy it by drawing too much attention to it.

If you try to keep it secret — something most cavers attempt — somehow, eventually it all comes out. Rumor spreads among local residents and there is a sudden stampede to be in on the action. It was just this way with the southern Alberta ice cave.

It's not as if there are no other caves to be probed in Alberta. Members of the Alberta Speliological Society and the McMaster University Karst Research Group have found several promising areas in Alberta's limestone mountains.

In fact, the McMaster group is still probing a cave system in Banff National Park believed to be the most extensive in Canada. At least two other major cave systems are known in Alberta and enthusiasts feel they've only scratched the surface.

Some caves can be entered with relatively little danger to either the cave or the visitor. At one such cave west of Bragg Creek you practically have to queue up to enter in summer.

And, of course, there is all the litter left behind by members of the throw-away generation.

But in many other caves, a highly specialized knowledge of ropes and cable ladders, compass and carbide lamps and many of the same skills used by mountaineers are required.

Even so, caving can still be highly dangerous. The initial foray by members of the McMaster team into the national park cave almost ended in tragedy when a flood cut off their exit.

Later it was discovered that while the entrance chambers were relatively free of water in the morning, the mid-day sun caused much melting of the snowpacks far above, and the melt water gushed into the cave.

National parks officials have attempted to keep the cave location a secret. But rumors have been spreading and last summer a maverick caver ventured in solo and sold a story about his "exploits" to an Edmonton publication.

Because of the high danger involved, it is highly unlikely that national parks officials will ever encourage visits to that cave.

What is more likely is that the Nakimu Cave in Glacier National Park, a famous turn-of-the-century attraction developed by the Canadian Pacific Railway in the grand old days of railroading, will be reopened to the public.

Containing more than three miles of mapped passages, Nakimu (translated as "place of whispering spirits") once had an extensive system of walkways and ladders.

But when CP punched the five-mile Connaught Tunnel through Mt. Sir Donald to escape the deadly avalanches of Rogers Pass and the Glacier House hotel was destroyed, the cave lapsed into obscurity.

By 1963 the walkways were so unsafe that parks officials closed the cave and special permits are needed to enter now.

Comprehensive plans for redevelopment of the cave have been drawn up by Dr. Ford. Other cavers, including Dr. Charlie Brown of the University of Alberta, plan to write a book

ONCE UPON A TIME . . .

The Rockies were just a twinkle in their glaciers' eye

By Don Truckey
(Herald staff writer)

Although Calgarians live within sight of the Rockies, one of the world's great mountain ranges, few know the story behind their formation.

In this four part feature, Herald reporter Don Truckey, with guidance from University of Calgary geology professor Dr. Len Hills, recounts the geological history of the Calgary area, ranging from gravel beds shaped and banked by the icy hands of glaciers only a few thousand years ago, to the 650 million year-old rock forming the eastern ramparts of the Rockies.

Included are the locations of highlights in the open geological record between Calgary and Mt. Yamnuska, if you wish to collect the series and pick out the notable features firsthand on your next leisurely drive through the area.

This is a story told in reverse — because the geology between Calgary and the Rockies proceeds from recent to ancient as one approaches the mountains.

It's also a story about vast forces and lapses of time, but it's told only through static, mute evidence. The Rockies, granted, are pretty impressive evidence. Some of it isn't quite so obvious.

For instance, the history of glacial movements around Calgary, the subject of this first installment, has to be pieced together from examination of glacial till (mixed rock) and gravel beds — not the most exotic pursuit imaginable.

Icesheets meet

But from it geologists have constructed a Calgary landscape far different from the one we know today.

The two major forces shaping this landscape were massive icesheets, one from the east and one from the west — and the 'twain did meet, right around Calgary.

These icesheets were part of the "ice ages," the world-wide geological and climatic period technically called the Pleistocene, which began roughly three million years ago and may not be over yet. Most geologists agree we are now in an interglacial period — thousands of years from now the ice may flow again.

The Pleistocene produced wild variations of ice cover over North America, but during the last big melting stage, dated between 55,000 and 40,000 years ago according to a study released only in the last few weeks, the scene around Calgary was this:

The edge of the eastern icesheet lay right along the west side of Calgary. It emanated from the Laurentian mountain area of eastern Canada (it's called the Laurentide icesheet) and was 12,000 feet deep in places. Over Calgary it was down to about 400 feet and tapered to an edge 40 feet thick which geologists have traced almost exactly.

Glacier's edge

Calgarians in the row of houses closest to the east side of the Sarcee Trail between the Bow Trail and Richmond Road are right over the spot where the Laurentide icesheet ended. Another convenient marker is the Sarcee Trail — Trans-Canada Highway interchange.

But the Laurentide icesheet wasn't the only game in town. The glaciers found in the Rockies today are the tiny remains of the Cordilleran icesheet, which filled up the mountains to a depth of 3500 feet during the Pleistocene period and pushed tongues of ice eastward out of the valleys.

Valley routes

Two of the major pathways this Cordilleran ice followed out of the mountains have been well documented by geologists. One came through the Athabasca valley past Jasper and Hinton and the other poured out of the Bow valley, directly west of Calgary (other glaciers, notably one through the North Saskatchewan River basin, flowed shorter distances from valleys between these two).

Both glaciers moved far enough east to run up against the Laurentide icesheet. The western edge of this huge, well consolidated sheet of ice was slowly moving from north to south (see diagram #1).

The Cordilleran glaciers deflected southward when they hit the Laurentide ice and were eventually absorbed into its flow. Ice from the Athabasca glacier was carried by the movement of the Laurentide sheet all the way into Montana. Ice the Bow valley glacier met the eastern sheet right at Calgary and glanced 50 miles south of here to Willow Creek.

'Erratic' boulders

We have some — literally — rock solid evidence of this glacial deflection.

Large boulders called "erratics," some as big as a garage, can be found in much of southeastern Alberta. By matching rock types, geologists conclude that these erratics were swept out of the mountains and carried south by the deflecting Cordilleran glaciers. Over 1000 have been found in an "erratic train" stretching all along the foothills south of Hinton. Some were moved as far as 400 miles.

One of the erratics from the Athabasca glacier rests in plain view on the north slope of Broadcast Hill (see photo). Correlations of rock types and a knowledge of glacial movement reveals that this rock was once a part of Mt. Edith Cavell. It probably toppled onto the glacier in a rockslide.

Around 50,000 years ago it was swept north past Jasper by the Athabasca glacier, swung east past Hinton through the Athabasca valley, then carried by the southward deflection all the way to Calgary (check diagram #1).

The erratic is on the north side of Broadcast hill. Seen from the Sarcee Trail — Trans-Canada Highway interchange, it lies directly below the westernmost radio tower.

The Broadcast Hill erratic settled at its present perch around 49,000 years ago — when the last big "ice age" in North America began drawing to an end. The erratic was deposited during the first stages of melting.

By 40,000 years ago the continental icesheets had melted almost completely (there was a resurgence 23,000 to 12,000 years ago, but it was small compared with the previous glaciation). Today we have to drive up to 6,500 feet to see the once huge Athabasca glacier, which has retreated almost to its source, the Columbia Icefields. The glacier is now reduced to a mere stub compared to its former size. The icefields above the glacier — still immense — are but a remnant of the Cordilleran icesheet.

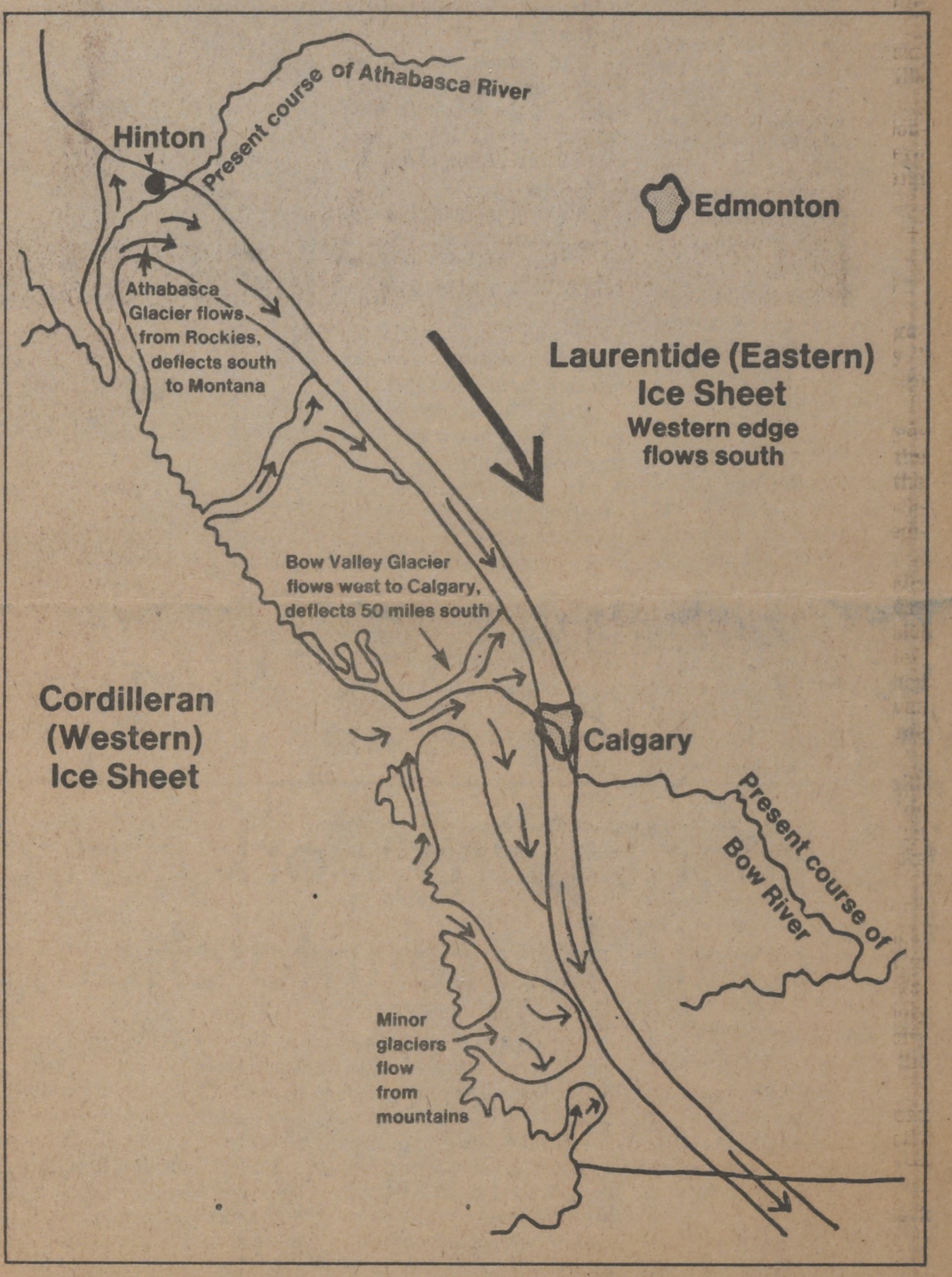


DIAGRAM ONE: SOUTHERN ALBERTA ABOUT 49,000 YEARS AGO
...two ice sheets meet over the area that is now Calgary and flow south.

U OF C PROFESSOR LEN HILLS ATOP 'ERRATIC'
. . . it was deposited on north flank of Broadcast Hill 49,000 years ago

Site of lake

In the intervening years, from 49,000 to 40,000 years ago, meltwaters from the icesheets gathered and flowed in quickly changing patterns around Calgary.

This is where the inglorious glacial tills and gravels come in..

They tell us of an ancient lake — Glacial Lake Calgary — which collected in what is now the Bow valley as the climate warmed and the western glacier retreated.

The Laurentide sheet was much bigger than the Bow valley glacier, so it melted at a slower pace. When the western edge of the Laurentide sheet lay exposed along the Sarcee Trail, the Bow valley ice had melted all the way back to the townsite of Morley.

Glacial Lake Calgary ran long and narrow from Morley to Calgary, bound on its western end by Nose Hill on the north and Broadcast Hill on the south (both "hills" were "shores" at the time — see diagram #2).

The Laurentide icesheet plugged the Bow Valley on the east, right over the present site of Calgary, and forced the lake to spill south directly over the path now followed by the Sarcee Trail south of the Bow Trail.

This glacier-fed river, called a spillway, fanned into a delta where the Sarcee Trail meets Richmond Road. Geologists know this because the gravel sediment along the path of the stream is suddenly made of larger rocks and spread over a wide area, indicating the slower moving waters of a delta. It's deeper too — there's enough of it to support the quarries south of Richmond Road.

The delta was on the edge of another lake, called Glacial Lake Elbow, which was the second step in a sequence of glacial lakes and spillways beginning at the toe of the Bow glacier at Morley and ending where Fort McLeod now stands.

As the Laurentide sheet slowly melted back from its position bordering the Sarcee Trail, the spillway shifted east with it. There are six grooves in the terrain of southern Calgary where successive spillways poured south past the icesheet. Thousands of Calgarians drive past one of these every day — the MacLeod Trail between Chinook Centre and Fish Creek in Midnapore follows the east bank of a shallow depression which once carried meltwaters from the Bow Glacier.

Same path

The last of these spillways took the path now followed by the Bow River. The Bow makes a big southern loop just after it passes the Calgary Zoo, where the old spillway hit the retreating Laurentide icesheet and poured south for the last time (incidentally, Calgary's notoriously rocky subsoil is glacial debris dropped here as the eastern ice withdrew).

Today the Bow River empties into Hudson Bay; the southward path around the Laurentide ice previously directed it into the Mississippi basin.

The Bow River is still a glacial spillway of sorts, being glacier-fed in the summer when the rest of this land is toasting medium brown. But it's young as rivers go, and has cut only a shallow channel in its time.

The "Bow Valley" between Nose Hill and Broadcast Hill is actually the route carved by the Bow glacier and later filled by Glacial Lake Calgary. The river trickling through it today is tiny compared to the waters which issued from the Cordilleran icesheet.

Nevertheless, the Bow River and its tributaries have made their mark around Calgary. The many stream-cut gulleys along the Bow Valley west of the city were made by waters flowing into the Bow after Glacial Lake Calgary had drained.

Timing important

The streams have easily slashed through the silt deposited along the valley's flanks by the old glacial lake. Frequent cuts into the side of the valley made during construction of the Trans-Canada Highway reveal the finely textured, easily eroded lake silts. These are visible for five miles west of the Sarcee Trail interchange as the Trans-Canada climbs up the banks of old Glacial Lake Calgary.

Incidentally, the timing of the meetings of the Cordilleran glaciers with the Laurentide icesheet is of enormous importance to archeologists in determining when men first entered the Americas.

A 1000 mile-wide land bridge, free of ice, between the Soviet Union and Alaska allowed passage to northern Canada, but there had to be a gap between the opposing ice masses in Alberta to allow men to pass through.

Men were certainly south of here well before 10,000 years ago, because accurately dated artifacts from that time have been found at the very tip of South America (unless men somehow paddled the Pacific, considered a remote possibility).

Major seaway

In their more humorous moments, archeologists speak of a glacial "trapdoor" along western Alberta yawning open and slamming shut now and then to allow men to skitter southward.

But enough of glaciers for now. We'll return to them when we move through the Morley Flats area, but now let's take another giant step back in our reverse story.

It's 65 million years ago. Calgary is on the western edge of a major seaway extending from the Gulf of Mexico to north of Edmonton.

There's a delta here, the mouth of a river which flows into the seaway from the Waterton area. To the west the landscape is rumpled, earthquakes are common — the Rockies are rising.

Sediments from the higher land to the west are flushed into the flatlands and deposited as deep layers of silt. As the millions of years pass, 2,000 to 3,000 feet of additional sediment stacks up on the silt.

The huge weight slowly compresses the bottom layers into bedrock. The overlying sediments are eroded away. Rounded hills remain.

Broadcast Hill, Nose Hill and the renowned Cochrane Hill are all testimony to this ancient silting and compressing action.

People often ask: "Where do the foothills begin?"

And they see these sloping lumps on the western outskirts of Calgary and say: "Right there."

But they're wrong.

False foothills

Strictly speaking, Calgary is not "the foothills city." The real foothills are 20 miles to the west.

It's all a question of geological process — and the process that formed the Broadcast, Nose and Cochrane Hills was simple sedimentary action.

In a sense, they're hills by default, because it was only nearby erosion which "raised" them in relief. And, as you recall, when Glacial Lake Calgary was full, the "hills" became "shores."

No, to be called a foothill, a rock formation has to do something more than sit tight while its neighbors wash away.

It has to rise.

So although we've backtracked 60 million years in the reverse story of Calgary's geology, we're still only on the outskirts of the city and haven't yet reached the foothills.

On Monday we'll head west and find out exactly where the foothills begin — where the rising starts — and see why we can mark the spot within a few feet.

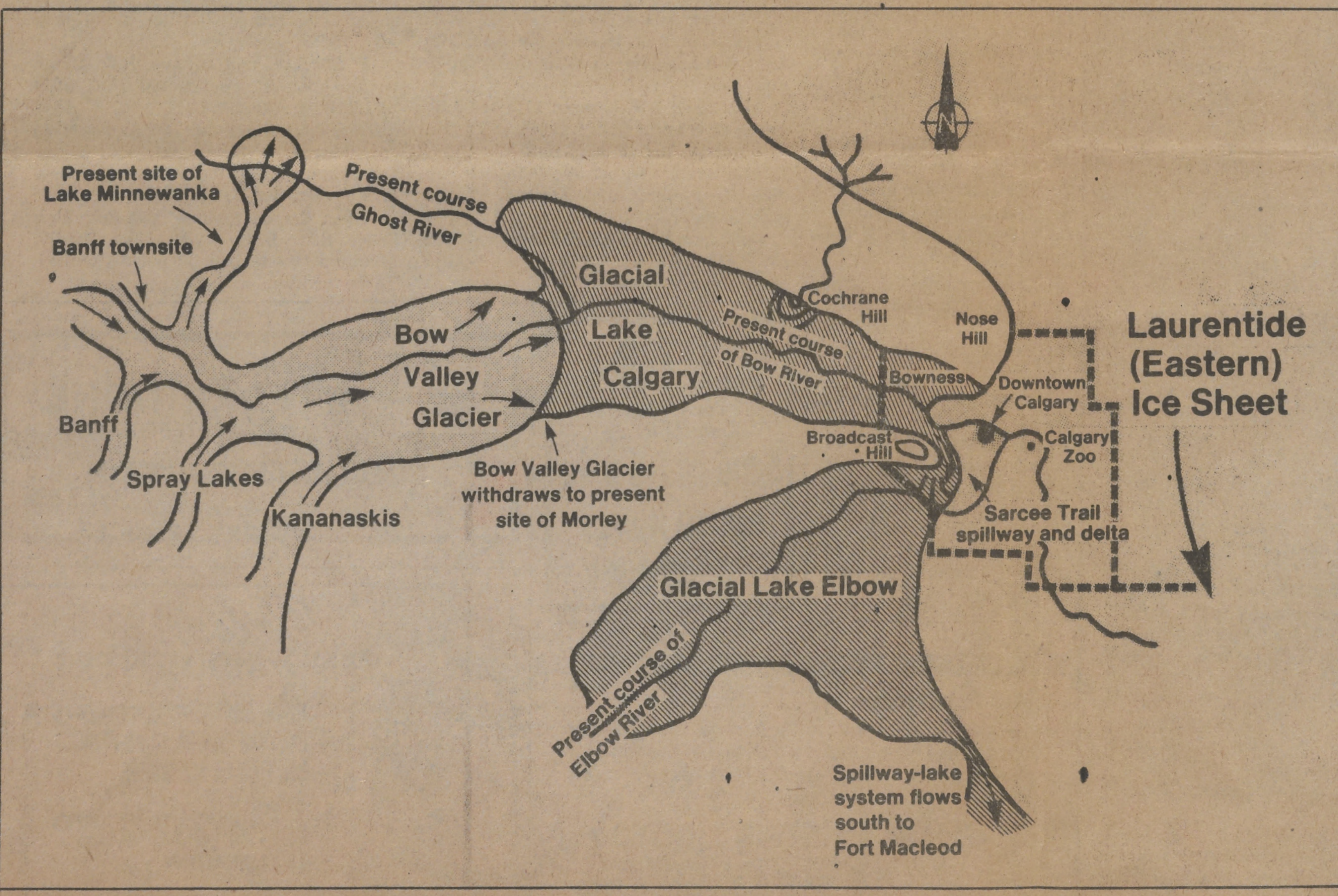


DIAGRAM TWO: CALGARY-BANFF AREA ABOUT 42,000 YEARS AGO
...two glacial lakes met at Calgary — today's hill were shores of lakes.

Grudgingly

Foothills accepts back pay report

Foothills Hospital has finally decided to accept a board of inquiry report calling for back pay for some of its certified nursing aides.

In a statement issued Friday, hospital authorities said they accept the report, delivered recently to the Alberta Human Rights Commission. It concluded that between July, 1973 and March, 1975 nursing aides at the hospital were paid less than male nursing orderlies, even though they did similar work.

The statement said Foothills accepted the report because "we were unable to achieve a compromise" with the Alberta Union of Provincial Employees in a meeting held Tuesday.

The Hospital had asked for the meeting with the union in an effort "to seek a more equitable solution" to the back pay issue.

Foothills initially delayed accepting or rejecting the report on two grounds:

— that it "does not cover about 100 of our employees" (nursing aides hired between July 1973 and March, 1975) but only those aides hired before July, 1973;

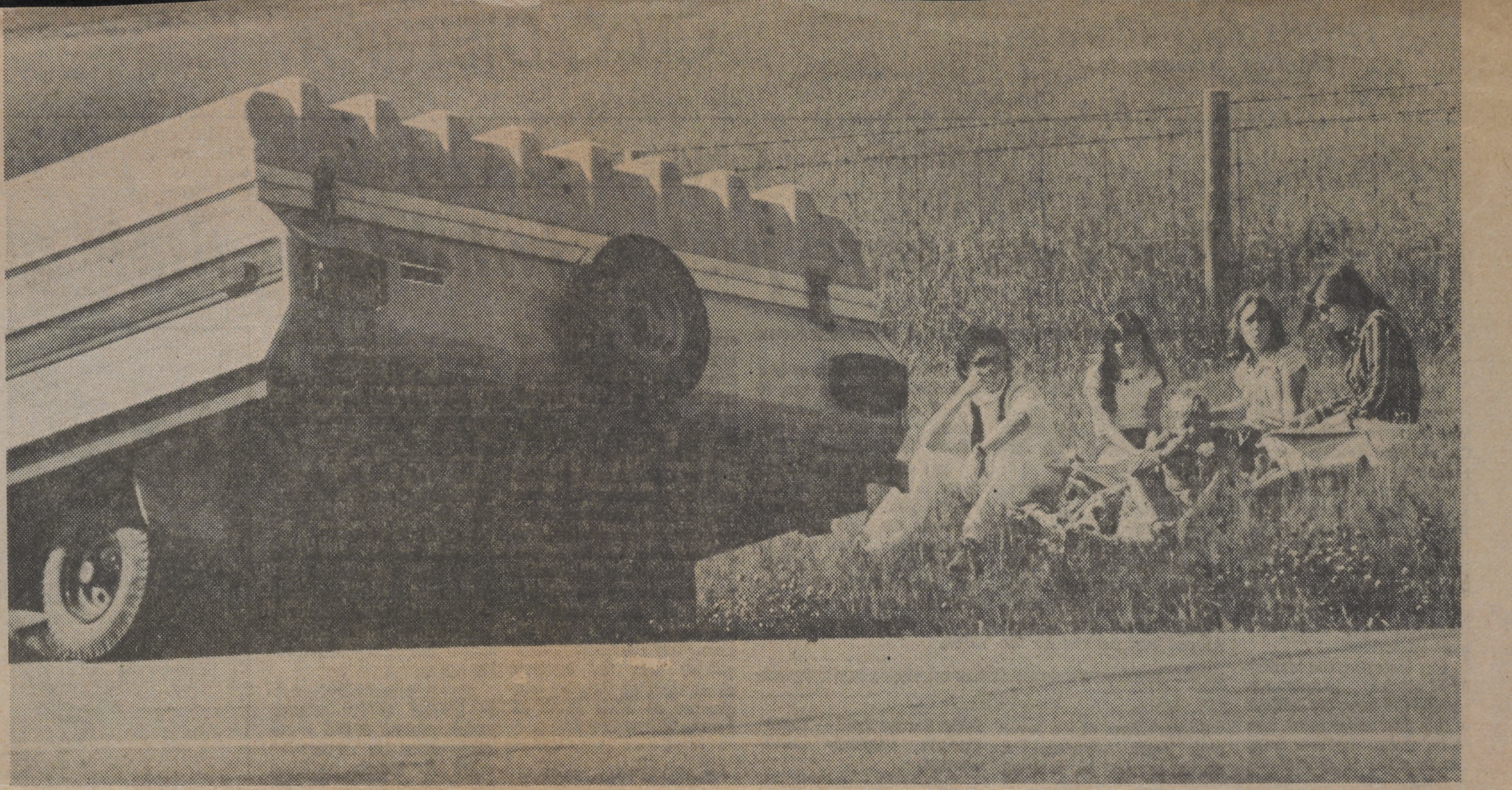
— that the report failed to suggest that the union may also have been guilty of discrimination by agreeing to unequal rates of pay in the first place.

The statement issued Friday said Foothills still objects to the report on both counts, despite having accepted the findings of the report.

Nursing aides at Foothills, who were on the job when the complaint arose in July of 1973, will be paid the difference between their pay rates and rates for nursing orderlies plus six per cent annual interest.

Foothills authorities did not say how much the back pay would amount to.

In 1975 Foothills and other hospitals across the province agreed to pay both aides and orderlies at the same rate. By the end of last year all but Foothills and W.W. Cross Cancer Institute in Edmonton had agreed to make up back pay totalling over $4 million. Cross agreed to pay earlier this year.



Ah, vacation time!

The Mellon family has learned how to live with car trouble. They were en route from Manitoba to Victoria this week when their car "started smoking." They pulled off the highway about 6 miles west of Calgary and took it easy while Mr. Mellon arranged repairs. Two days before that they suffered a broken axle. But still they were able to see the bright side, perhaps by recalling a 1975 vacation during which their van caught fire and was destroyed.

(Herald photo by Sue Brun)

Owner's hard work can change bargain horse into champion

By Carol Conway
(Herald staff writer)

Several million dollars worth of horseflesh has been on the hoof in Calgary this week — some of the finest Arabian horses in the world.

But the horse-lover of average means, watching the Canadian national Arabian championships from the wooden benches of the Stampede Corral, need not lose heart.

Anyone with an investment of $1,000 or less and willing to put in some years of hard work, has a chance of joining the list of national champions lining up for awards in the years to come. Or so says Owen Panner, president of the International Arabian Horse Association.

Panner, of Bend, Ore., was in Calgary Friday to promote the show and to dispel the idea of an exclusive club of Arabian horse owners.

"We have 25,000 association members in Canada and the United States. More than 21,000 of these own only one horse," he said.

"An Arabian horse can cost from $1,000 to $1 million, but if you asked about some of these super expensive horses competing in this show you'd find many of them started off as $700 weanlings or were the offspring of $1,500 broodmares," said Panner.

He said it is the years of hard work and training put in by the individual owners — and the awards and titles won in the show ring — that can boost a horse's value to a four-figure sum.

Panner hopes the monetary value placed on Arabian horses won't obscure the intrinsic qualities that make them the most sought after horses in recent years.

"An Arabian horse in action is a happy, beatiful and exciting thing to watch. As soon as it moves you are caught in its spell," he said.

People who own Arabs often display these characteristics in their own lives, Panner maintains.

"They are exciting and adventurous people who want something special out of life," he said.

They are also in tune with the late 20th century movement toward ecology and things natural, added Panner.

"I certainly believe this is one reason for the rising popularity of the Arabian horse in recent years," he said.

"Its action is beautiful and there is nothing forced or unnatural about it."

Panner admits however that Arabian owners have probably been selfish in keeping these beautiful horses to themselves.

"It's true that we haven't been satisfied with the crowd turn-outs for this show, or at previous shows," he said.

"But it's not altogther their fault. I think we have to advertise more and make the Calgary community realize that these national championships, being held in their home city, are something for them to get involved in."

The 20th Canadian national championship and half Arabian championship, which started Wednesday, is the 16th to be held in Calgary.

Next year it goes to Vancouver, but that doesn't mean show organizers are giving up on Calgary.

"It's been held here so often because there is such a nucleus of Arabian horse owners in this area. Interest now is starting to spread," said Panner.

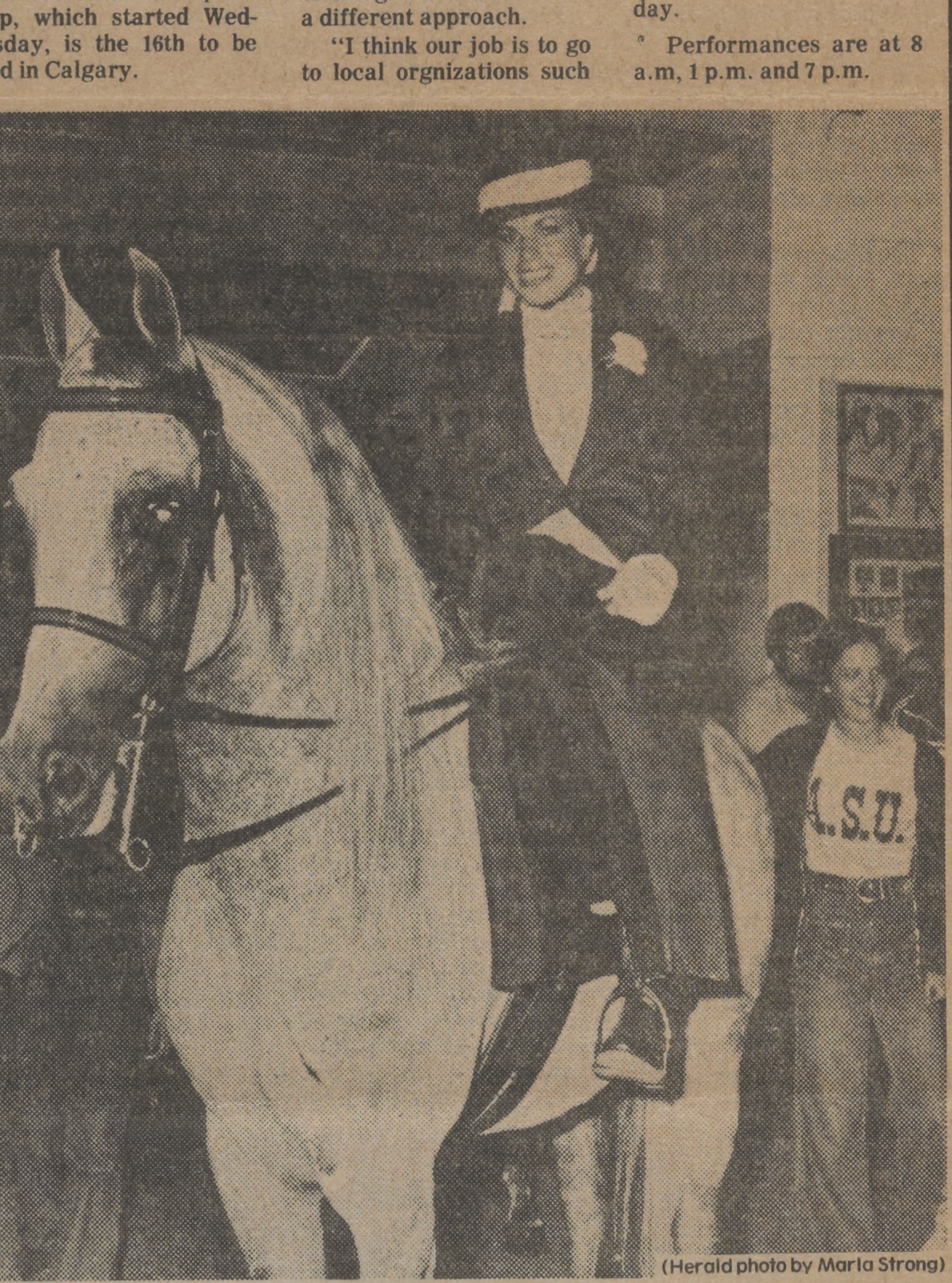
He expected the show would return to Calgary because of the "beautiful facility available here" at the Stampede Corral, but said organizers would take a different approach.

"I think our job is to go to local orgnizations such as the Chamber of Commerce and tourist association and remind them that a show like this, with over 600 exhibitors from all over North America, can bring in an extra $3 to $5 million in the city.

"It's then up to the community to respond by being interested in the show while it is here."

The show runs all weekend with the finals of most championship classes being held today and Sunday.

Performances are at 8 a.m, 1 p.m. and 7 p.m.



(Herald photo by Marla Strong)

CENTURY-OLD ENGLISH SIDE SADDLE RIDING LIVES ON . . . first time winner Marilee McIntoo aboard "Callisto"

Elegance wins at Corral

By Don Truckey
(Herald staff writer)

Arabian horses and Stampede wrestling have absolutely nothing in common.

But one of the quirks of the Canadian National Arabian and Half-Arabian Horse Championships has some of the stables located adjacent to the weekend wrestling matches — and Friday night it only served to make the winner of the Ladies Side Saddle showing look doubly elegant.

Marilee McIndoo, of Redding, California, looked every inch an aristocrat dressed in an English riding costume identical to those worn 100 years, and, like a proper lady, smiled irrepressibly in the cool stables as outside the rain flooded down and the wrestling crowd roared vulgarly in the background.

The pert 21 year old hugged her trainers, her Arabian named "Callisto," her mother — it was her first win in a national championship, the biggest mark so far in a show career that began when Marilee was six.

"The U.S. championship is still the big apple for me, because I live there, but the Canadian championship is just as important," she said.

Like many riders at the show, which ends on Sunday, she's part of a family operation which raises and exhibits Arabians. The McIndoo family has been in the business for 20 years.

Marilee rides astride as well, but says she's glad to see the English side saddle being revived after nearly dying out 20 years ago.

She describes herself as a student when she's "between horseshows."

Shotgun tryout near completion

The experiment to decide how many shotguns should be mounted in Calgary police cars is now nearing an end.

"We shall be asking for reports within the next couple of weeks," deputy Chief Howard Leary said Friday. "The final analysis should be with Chief Sawyer before the end of September."

At the moment 10 cruisers deployed throughout the city are packing the weapons and each of the five district sergeants has five shotguns to take to emergency scenes.

Some of the 10 experimental weapons are mounted in a vertical position. Some horizontally. Others are kept in the trunk.

"As yet," Leary said, "we have no feedback on which method suits the men best."

The original, tentative plan was to buy 54 shotguns, two for every zone, but it has not been agreed whether that many are needed or if particular zones require only one, with a greater concentration of weapons downtown.

"Once more we will have to wait for the reports to come in before a decision is reached," said Leary.

None of the shotguns now on the streets has been fired on business.

"There have been occasions when the men have had to take them out to confront somebody or when attending a certain type of complaint where guns are known to be present. Fortunately, however, they have not had to use them," the deputy chief said.

The department is also experimenting with screens separating front and back seats in cruisers.

At first officers rejected the idea, mainly on the grounds of confinement and lack of mobility.

But since the May murder of Constable William Shelever, the cry has again gone out for better in-vehicle protection.

So far only one car is fitted with a screen, though more will be installed in the new compacts when they arrive.

Surprisingly, requests for bullet-proof vests have not risen since the Shelever killing.

About 350 vests are now out on issue, and a fresh batch — including some to fit women — are due next week.

Calgary policemen are not obliged to wear the armored vests. As Leary put it: "It is strictly a voluntary thing."

The argument that they are uncomfortable and restrictive apparently does not hold good.

Tory is true blue despite Grit card

By Mary Gilchrist
(Herald staff writer)

When Tory Ron Tesolin plunked down $3 for a membership in the federal Liberal party he started some political tongues wagging, but he pooh poohs the idea that he has switched allegiance.

The fact he is a Conservative MLA, representing the provincial constituency of Lac La Biche-McMurray, is beside the point, he said Friday.

He took out the membership at a meeting in Lac La Biche where federal cabinet minister Jack Horner spoke. Horner last spring, tired of sitting as an opposition MP for 14 years, crossed the floor and was taken into the Trudeau cabinet as minister without portfolio.

Tesolin said the fact he took out a Liberal membership after hearing Horner speak caused a bit of a stir in the cities but that was because city folk don't understand the politics of the north.

Party lines harden during election campaigns but at other times everyone goes to everyone else's political meetings. A membership card would entitle him to the literature and information he should have about the party, he said.

"I've been going to every political meeting I could for the last 15 years," the young MLA said.

His own campaign manager, Phil Couteny, votes Liberal federally as do half his campaign workers, he said.

ALthough he admires Horner, Tesolin said he would not vote Liberal in the next federal election. He was campaign manager three times for the incumbent Tory MP for Athabaska, Paul Yewchuk, and he will vote Conservative next time round as well.

He said he does not believe his federal Liberal membership will get him into trouble with provincial Tories. He has discussed it informally with party officials.

He said he doesn't expect Liberals to pick up much support from Alberta Conservatives, even with Horner's presence.

"The Liberal organzation is in total disarray. I just don't see any threat of that happening," he said.

City road projects

(Each Saturday The Herald publishes a list of road projects and traffic trouble areas motorists can expect to encounter during the following week. The information is supplied by the city transportation department.)

Macleod Trail between Southland Drive and Anderson Road. Top lift paving. Traffic maintained in two directions. Aug. 22-26.

Anderson Road between CPR tracks and Bonaventure Drive. Top lift paving. Traffic maintained. Aug. 22-26.

Deerfoot Trail between 16th and 17th Avenues N.E. Top lift paving. Traffic maintained. Aug. 22-26.

Edmonton Trail between 16th and 34th Avenues N.E. Paving. Traffic maintained. Aug. 22-26.

14th Street S.W. between 11th and 17th Avenues. Planing and paving. Traffic maintained. Aug. 22-26.

14th Street S.W. between 26th and 38th Avenues. Planing and paving. Traffic maintained. Aug. 22-26.

14th Street N.W. between Kensington Road and 5th Avenue. Planing. Traffic maintained. Aug. 22-26.

Northmount Dr. N.W. between Charleswood and Northland Drives. Planing. Traffic maintained. Aug. 22-26.

4th Street N.W. between 11th and 12th Avenues. Top lift paving. Traffic maintained. Aug. 22-26.

6th Avenue S.W. between 2nd and 3rd Streets. Installation of concrete bus lane. North curb lane on 6th Avenue between 2nd and 3rd Streets will be closed to traffic. Aug. 19 to 27.

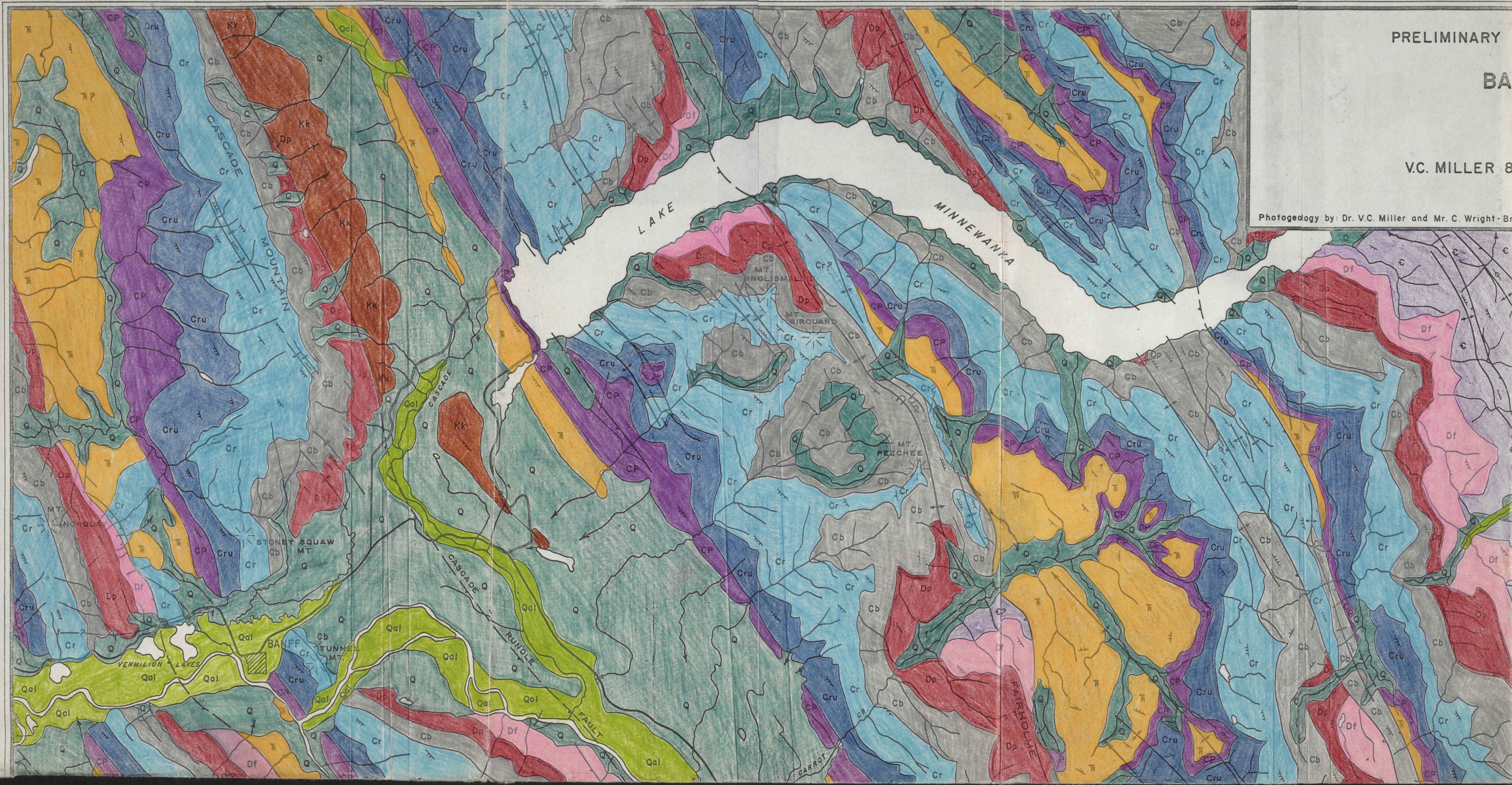
19th Avenue and Spiller Road S.E. Storm sewer connection. Traffic maintained. Aug. 23-24.

4th Avenue and 4th Street S.W. Storm sewer connection Traffic maintained Aug. 24-25.

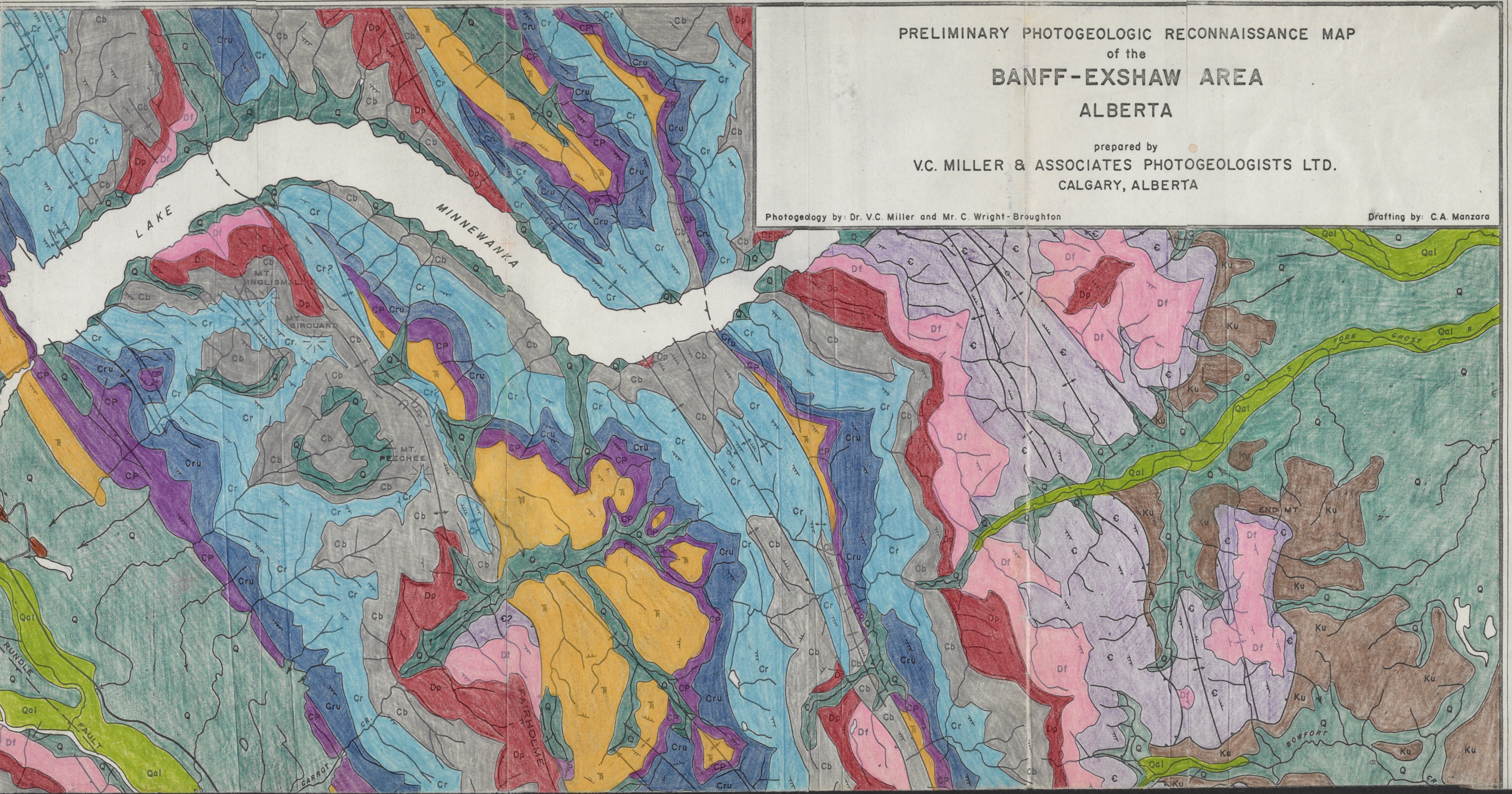
37 St. S.W. and 23 Ave. S.W. Catch basin leads connected. Traffic maintained. Aug. 23-24.

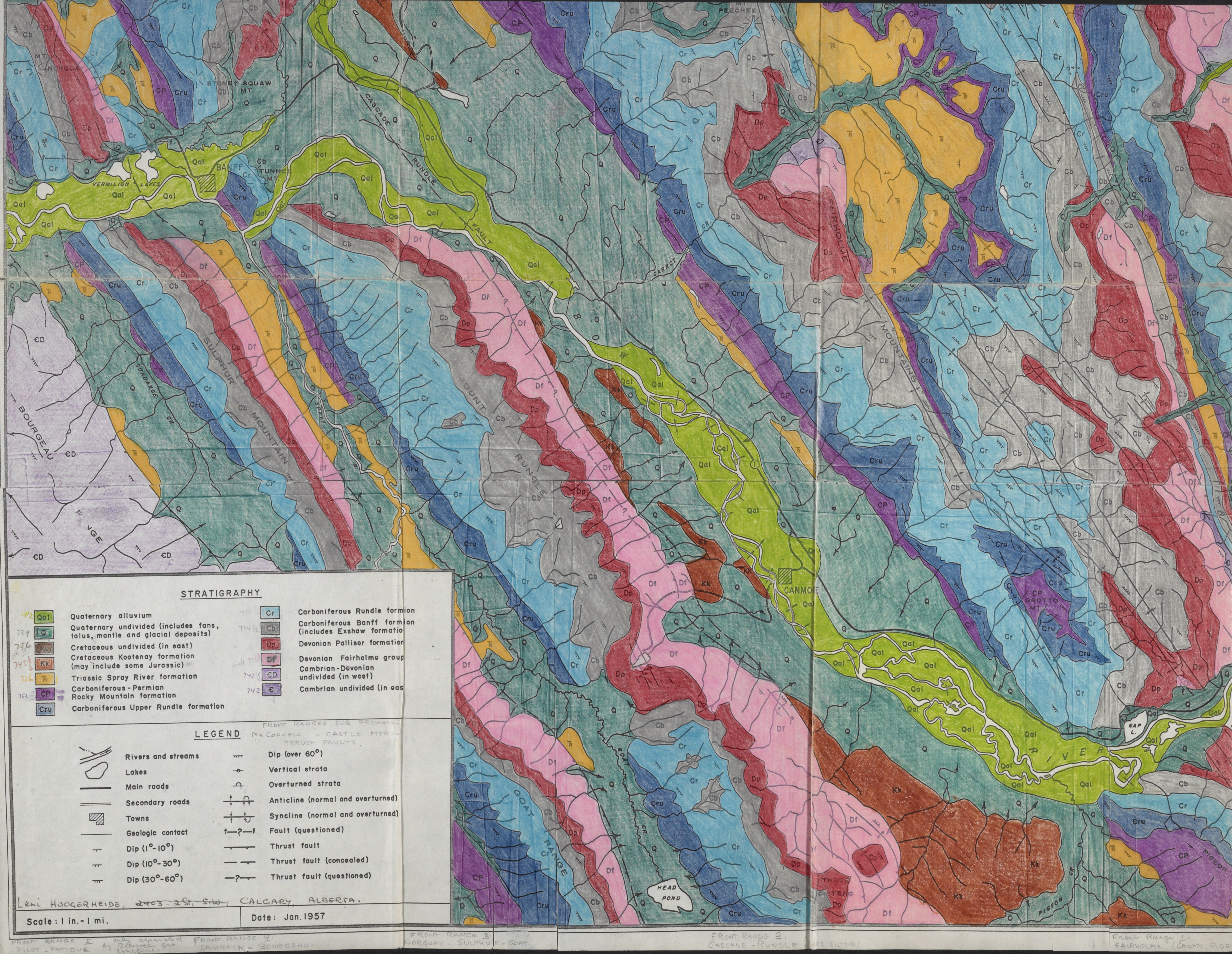
Trans Canada Highway (16th Avenue N.W.) at University Drive Bridge. Bridge redecking. Traffic maintained, one lane in each direction. Three weeks.

Trans Canada Highway and Bow River Bridge N.W. Bridge redecking. Traffic maintained, one lane in each direction. Three weeks.



PRELIMINARY
BA
V.C. MILLER 8
Photogeology by: Dr. V.C. Miller and Mr. C. Wright-Br
CASCADE MOUNTAIN
LAKE MINNEWANKA
MT. INGLISMALDIE
MT. GIROUARD
MT. PEECHEE
MT. NORQUAY
STONEY SQUAW MT
CASCADE
CASCADE RUNDLE FAULT
BANFF
TUNNEL MT
VERMILION LAKES
FAIRHOLME
CARROT CR.


PRELIMINARY PHOTOGEOLOGIC RECONNAISSANCE MAP
of the
BANFF-EXSHAW AREA
ALBERTA
prepared by
V.C. MILLER & ASSOCIATES PHOTOGEOLOGISTS LTD.
CALGARY, ALBERTA
Photogeology by: Dr. V.C. Miller and Mr. C. Wright-Broughton
Drafting by: C.A. Manzara
LAKE
MINNEWANKA
MT. INGLISMALDI
MT. GIROUARD
MT. PEECHEE
FAIRHOLME
RUNDLE
FAULT
END MT
GHOST
FORK
BOWFORT



STRATIGRAPHY
Qal Quaternary alluvium
Q Quaternary undivided (includes fans, talus, mantle and glacial deposits)
Ku Cretaceous undivided (in east)
Kk Cretaceous Kootenay formation (may include some Jurassic)
Tr Triassic Spray River formation
CP Carboniferous - Permian Rocky Mountain formation
Cru Carboniferous Upper Rundle formation
Cr Carboniferous Rundle formion
Cb Carboniferous Banff formion (includes Exshaw formatio
Dp Devonian Pallisor formation
Df Devonian Fairholme group
ЄD Cambrian-Devonian undivided (in west)
Є Cambrian undivided (in eas
LEGEND
FRONT RANGES SUB PROVINCE. McCONNELL - CASTLE MTN - THRUST FAULTS.
Rivers and streams
Lakes
Main roads
Secondary roads
Towns
Geologic contact
Dip (1°-10°)
Dip (10°-30°)
Dip (30°-60°)
Dip (over 60°)
Vertical strata
Overturned strata
Anticline (normal and overturned)
Syncline (normal and overturned)
Fault (questioned)
Thrust fault
Thrust fault (concealed)
Thrust fault (questioned)
Leni HOOGERHEIDE, ~~2403 - 2 St. S.W.~~, CALGARY, ALBERTA.
Scale: 1 in. - 1 mi.
Date: Jan. 1957
MT NORQUAY
STONEY SQUAW MT
BANFF
TUNNEL MT
VERMILION LAKES
CASCADE
RUNDLE
FAULT
CARROT
BOW
SULPHUR MOUNTAIN
MOUNT RUNDLE
CANMORE
FAIRHOLME
MOUNTAINS
GROTTO MT
BOURGEAU
GAP L.
RIVER
GOAT RANGE
HEAD POND
THREE SISTERS
PEECHEE
PIGEON
FRONT RANGE 5 only separated by Brewster Crk Syncline. PILOT - FATIGUE
FRONT RANGE 4 SAWBACK = BOURGEAU.
FRONT RANGE 3 NORQUAY - SULPHUR - GOAT
FRONT RANGE 2 CASCADE - RUNDLE (3 SISTERS)
FRONT RANGE 1 FAIRHOLME (GROTTO, PIGEON

FRONT RANGE 3. ... SULPHUR - GOAT

FRONT RANGE 2. CASCADE - RUNDLE (THREE SISTERS)

Front Range 1. FAIRHOLME (GROTTO, PIGEON)

2 minor faults: Exshaw, Lac des Arcs.

WEIRD WORLD

The 400-kg Titanis once stalked Florida and Central America

"But it really is bizarre here." Renowned ecologist Tim Flannery hails from Australia, home of the paralysis tick and the duck-billed platypus, yet he laughingly insists that North America can out-weird his continent any day. "When I came to Boston for the first time in 1997, I was stunned," he recalls. "It was mid-September, 100 per cent humidity, a vast biomass of plants and insects, dazzling green colours. Six weeks later, it was all gone. That doesn't happen in Australia, or anywhere else." Flannery's astonishment at North America has only grown since that trip, and is on full display in *The Eternal Frontier* (Publishers Group West, $42.50), his extraordinary natural history of the continent.

Against a very deep background—he begins his book with that "most unfortunate day" 65 million years ago when it's widely believed a dinosaur-annihilating asteroid slammed into the Earth—Flannery describes a landmass forever subject to the shock of the new. The asteroid killed large creatures around the world, but North America bore the brunt of the disaster. The 10-km-wide rock was coming from the south when it struck near Mexico's Yucatan Peninsula, sending shock and tidal waves, and tonnes of molten rock—what Flannery calls the "divot" gouged out by the impact—up to 7,000 km north. North America was scrubbed almost clean of life. Then there are the repeated revolutionary effects of the continent's most distinguishing characteristic, its capacity to amplify climactic change.

North America is a giant inverted wedge, 6,500 km across in the frozen Arctic and only 60 km wide at its southern end. Not only are there no east-west mountain ranges to break the north-south air flow, but the Rocky and Appalachian mountains actually reinforce a funnel effect, channelling super-chilled air south in winter and equally hot winds north in summer, producing the blink-of-an-eye transitional seasons that so amazed Flannery in Boston.

Flannery's "climactic trumpet" plays two tunes, however, the seasonal variation of extreme heat and cold, and a longer note, played out over geological time, that rapidly shifts North America between greenhouse and ice age modes. Fifty million years ago, crocodiles swam in the Arctic, but 18,000 years ago more ice than is found today in Antarctica covered almost all of Canada. It would take only a two degree-drop in deep-sea temperatures for those glaciers to return.

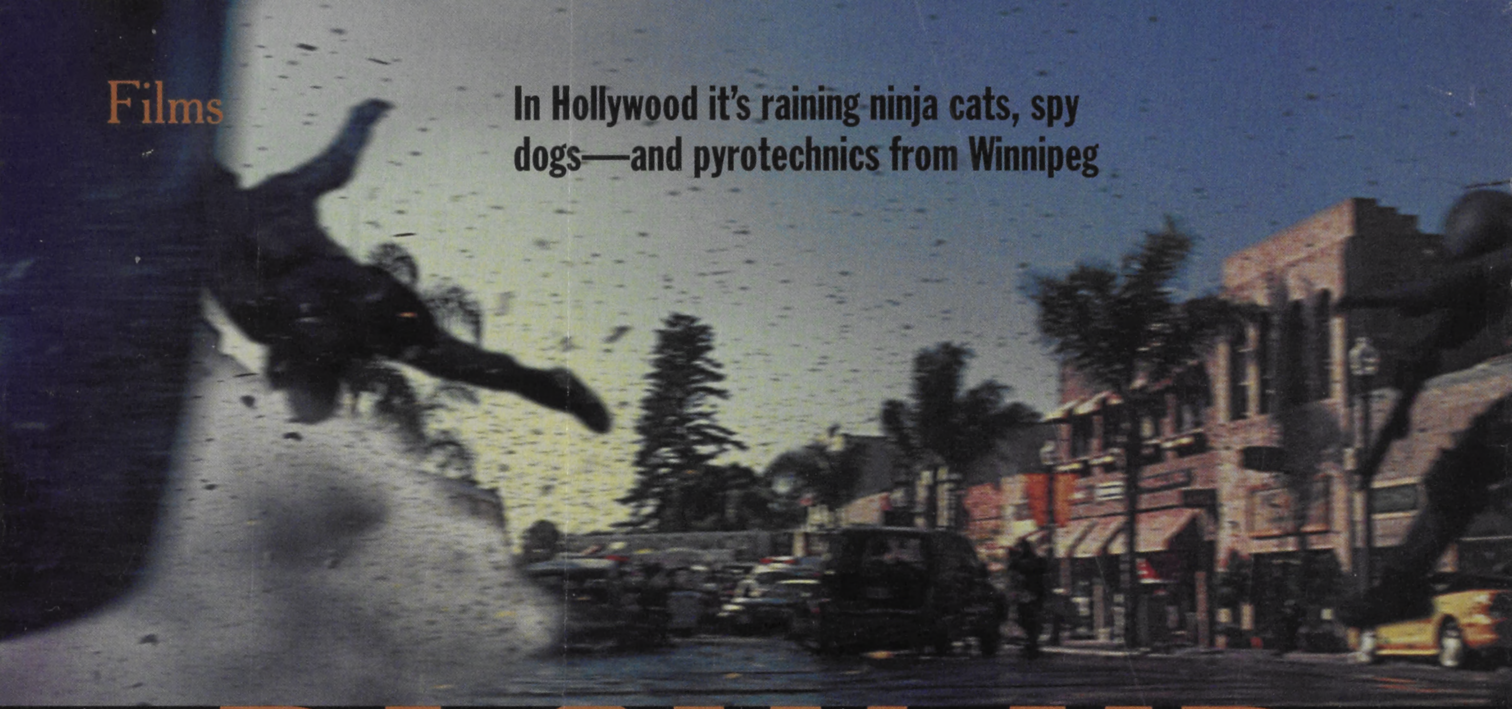
AN AUSSIE ECOLOGIST MARVELS AT NORTH AMERICA'S STRANGENESS

The 45-year-old University of Adelaide professor is at his most thought-provoking when he discusses the impact made by humans. At the end of the last ice age, some 15,000 years ago, much of the continent looked like Africa. Mastodons and mammoths, recent invaders from Asia, roamed the land, keeping back the forests and allowing native horses and camels to thrive. Into this Eden came another ecology-changing wave of Asian immigration. The big-game hunters of so-called Clovis culture were either the first Americans or the first who knew how to exploit the mega-fauna. Within 300 years of Clovis's appearance, all the giants were gone. Controversy is intense over the cause of their extinctions, with aboriginal Americans and many scientists arguing for climate change. But Flannery, displaying a very Australian disdain for political niceties, has no doubts—"Oh, they disappeared into a black hole, all right, the one between the Clovis nose and chin. It's a dangerous, damaging myth to say that native Americans, or anyone else, are natural-born conservationists."

What the first Americans experienced was the same phenomenon that European settlers underwent more recently: ecological release. The newcomers entered a land of plenty that offered no check on their technology—not, that is, until the bounty was consumed. Native Americans did adapt themselves to the end of the age of plenty, fanning across the continent to create societies—many unlike any others on earth—in harmony with their local ecologies. The European onslaught has been far worse, encompassing the extinction of human and animal groups, massive deforestation and water poisoning. Nor have we yet realized in our bones, Flannery argues, that the frontier is gone. "I'm not convinced that a fully adapted American culture exists yet." Until one does, North America, land of extremes, will continue to suffer its latest invaders.

Brian Bethune

In Hollywood it's raining ninja cats, spy dogs—and pyrotechnics from Winnipeg



BLOW-UP

By Brian D. Johnson

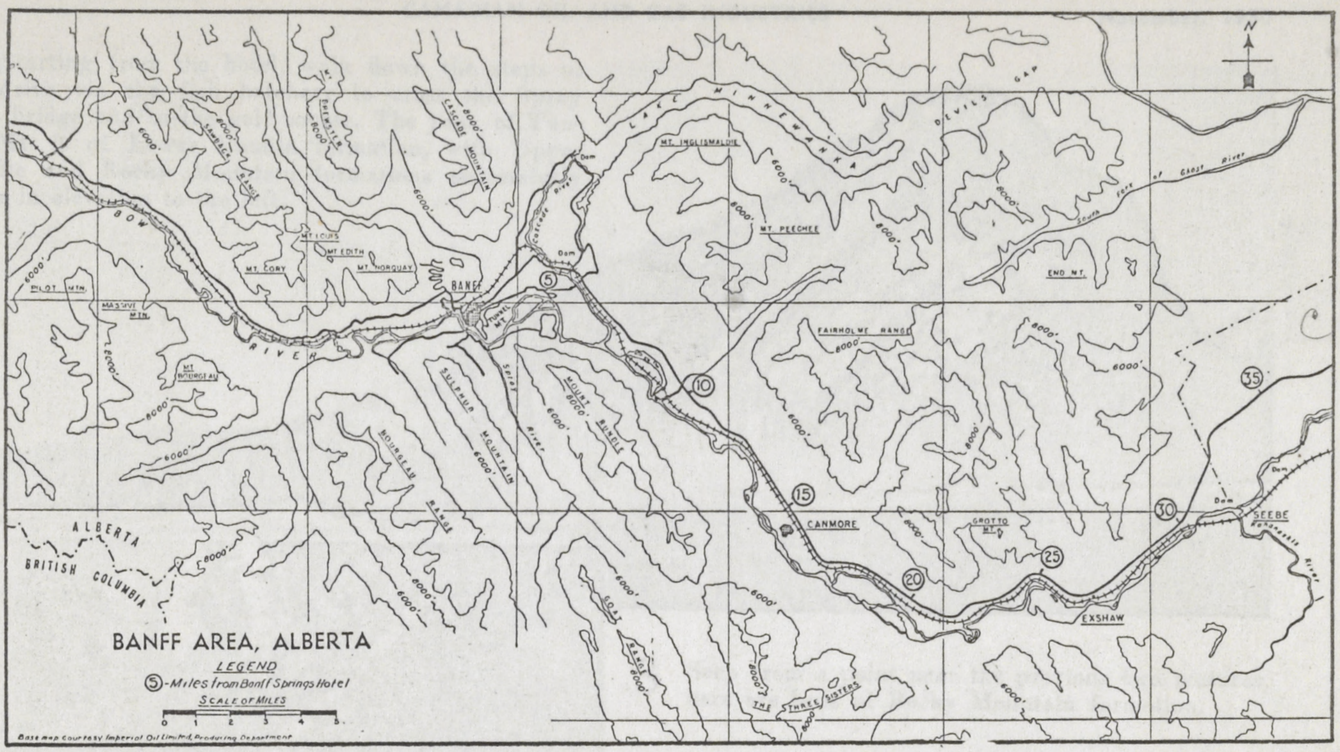
I don't usually get excited by explosions in movies. Kaboom. Fireball. Stuff goes up, stuff comes down, and my mind turns to thoughts of global warming. But the explosion in *Swordfish*, a thriller starring John Travolta as a high-tech thief, is something else. It occurs in the first few minutes of the film, and after it everything else seems anti-climactic, with the possible exception of Halle Berry lying naked in a chaise longue. Travolta's villain is holding 30 hostages in a Los Angeles bank, each wrapped with plastic explosives, ball bearings and electronic detonator collars. When a trigger-happy cop shoots one of the bad guys, a female hostage gets loose and is blown to kingdom come. Filmed in super slow motion—what the makers of *The Matrix* dubbed "bullet time," capable of capturing a bullet in flight—the explosion is stretched over 42 seconds on screen. We see it as an unbroken panorama of cars and bodies flying through the air, a storm of ball bearings and shattering glass—as if the camera were moving *through* the explosion, surfing the shock wave. As carnage goes, it's not gory; it's beautiful. And this is carnage Canadians can be proud of: it was made in Winnipeg.

The footage that served as the raw material for the *Swordfish* explosion was shot in California over a period of three days, with multiple arrays of more than 180 still cameras firing in programmed sequences. But the task of plotting the sequences, and weaving the bits and pieces into a computer-simulated whole, was done by a small Winnipeg-based visual effects company, Frantic Films. Fifteen Frantic employees took eight months to compose the shot for Warner Bros., which spent almost \$5 million on the explosion—roughly the cost of two modest Canadian features.

Ken Zorniak, the 30-year-old co-founder of Frantic Films, created the company four years ago with partner Chris Bond. Recalling how he landed the *Swordfish* contract, he says, "We hopped in the car, threw a couple of computers in the back and headed down to L.A." Their fledgling company, which now has 21 employees, outbid Hollywood's special-effects giant, Industrial Light and Magic. By then, Frantic already had a reputation, having won an Emmy nomination for making digital snow in the 1999 Stephen King mini-series, *Storm of the Century*. Simulating winter might come naturally to someone from Winnipeg. But with the explosion in *Swordfish*, Zorniak says, "We've shown that we can do a much wider range of things than snow. It's definitely the largest bullet-time effects shot ever done." And basing all the digital work in Winnipeg was no handicap, he adds. "When you can ship stuff back and forth with FedEx and the Internet, it doesn't really matter where you are."

Movies, of course, create their own reality. While the whiz kids at Frantic Films were doing their bit for mankind by helping to blow up a hostage real good, at the other end of the creative spectrum, Winnipeg auteur Guy Maddin has been raking in awards for his six-minute masterpiece,

Warner Bros. Pictures



Rock Formations at Banff

*By Floyd K. Beach**

The editors of *Canadian Oil and Gas Industries* were pleased to present this feature, prepared especially for the Alberta Society of Petroleum Geologists, the Geological Association of Canada and their guests of the American Association of Petroleum Geologists and the Society of Exploration of Geophysicists on the occasion of their meeting at Banff Springs Hotel, September 5 to 8, 1950. It offers, we believe, the essentials for interesting excursions to view the wide variety of geological formations in the environs of Banff. Viewpoints are expressed in miles from Banff Springs Hotel as measured by automobile speedometer over some of the better roads in the vicinity.

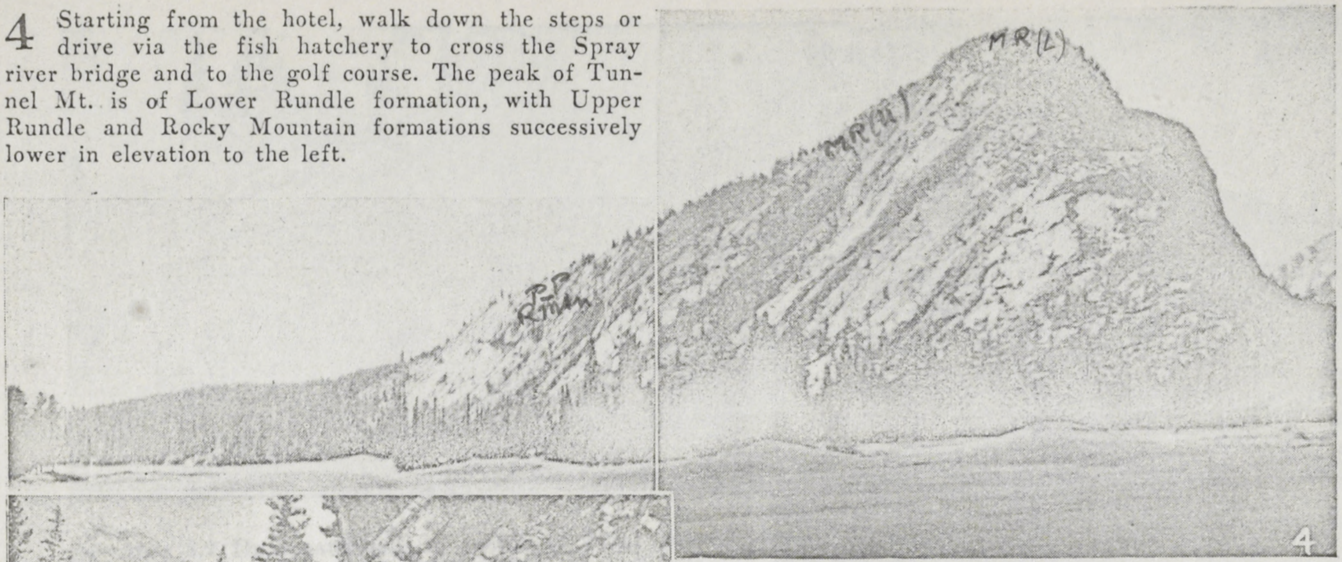
1 Banff Springs Hotel from the shoulder of Tunnel Mt. 1.7 *miles* walking or driving via Bow river bridge and Buffalo street. The hotel is built on Spray River formation of Triassic age. The falls are cut through beds of the same formation, and the building stone for the walls of the hotel came from it.

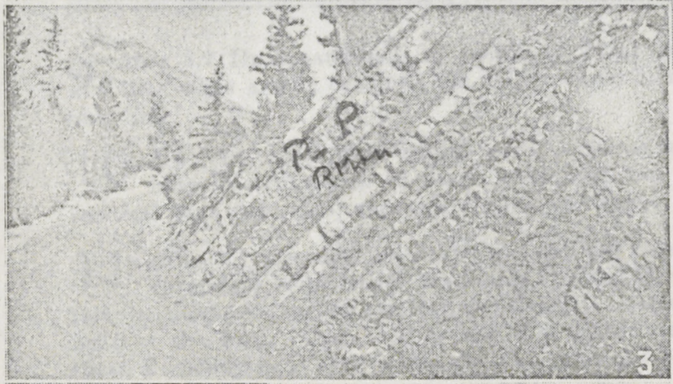
2 From the same viewpoint as the previous photo, note uppermost beds of Rocky Mountain formation of Permo-Pennsylvanian age. Harder than the overlying Spray River beds, Rocky Mountain beds form the wall rising from the falls and make a natural parapet for the road.

Photos by the author except where otherwise acknowledged. Base map courtesy Producing Department, Imperial Oil Limited.

**Western Field Editor,*
Canadian Oil and Gas Industries.

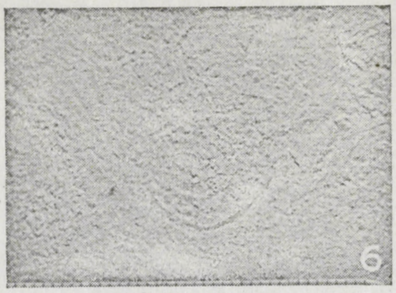
4 Starting from the hotel, walk down the steps or drive via the fish hatchery to cross the Spray river bridge and to the golf course. The peak of Tunnel Mt. is of Lower Rundle formation, with Upper Rundle and Rocky Mountain formations successively lower in elevation to the left.



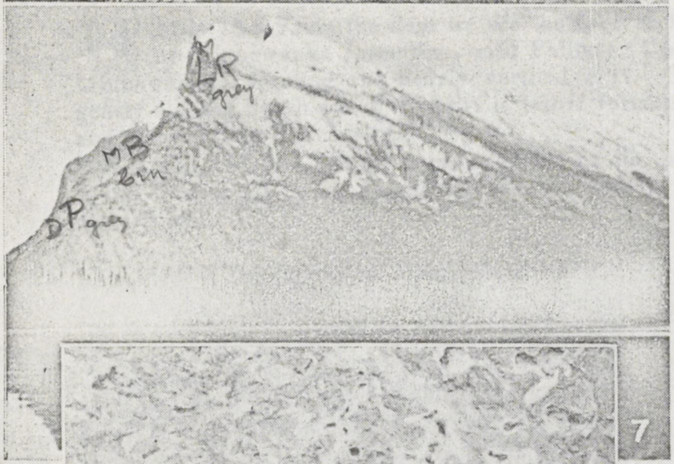


3 Seen from a point near the previous two pictures, here are beds of Rocky Mountain formation.

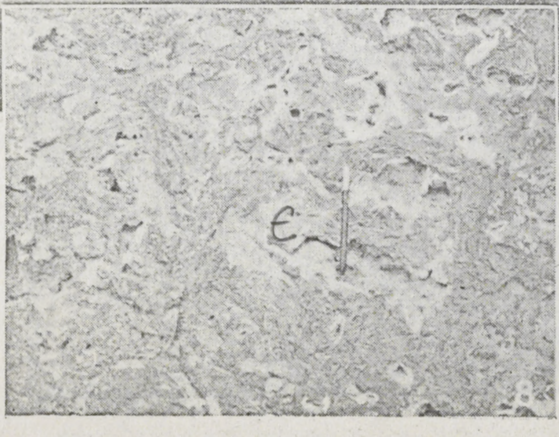
5 Close to the first green of the golf course is a trail passable for cars leading south. About ½ *mile* along this trail, through a gate in a high fence, and nearly up to a footbridge over Spray river. Here is the quarry in lower beds of Spray River formation from which has come most of Banff's building stone.



6 Poorly preserved ammonite from Spray River formation. Scale at bottom is in sixteenths of an inch.



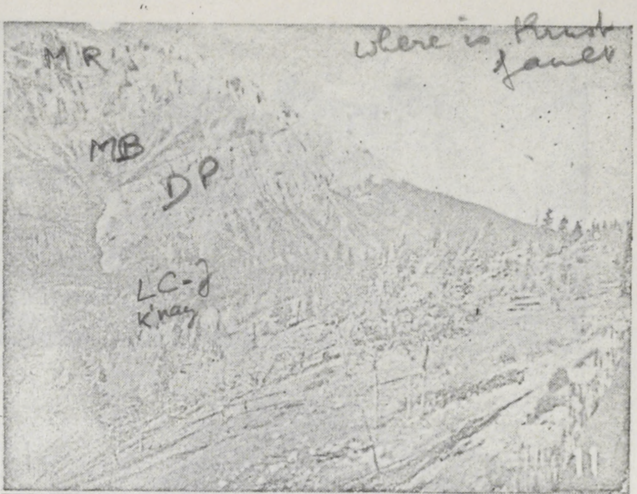
7 About 4 *miles* from the hotel on the road to Lake Louise. Mt. Rundle reflected in the water of Vermilion lakes. Crest is of Lower Rundle formation, cliff forming. The gentler slope in the left shoulder is Banff formation, of softer shale. Below the Banff formation, Palliser formation, also cliff forming, drops steeply where glaciation has gouged it.



8 Along road toward Lake Louise about ½ *mile past mile post* 6. Highway construction has exposed vuggy limestone with recrystallized calcite. This exposure is on the north side of the road and is in Cambrian beds. The pencil is 5½ inches long.

(And on the next page . . .)

Photos 9.) to 14.) are from a drive to Lake Minnewanka via Calgary highway for 5.6 *miles,* thence via gravelled road leaving highway to the left.



9 *Mile* 3.7 Dune sand tells of events in Pleistocene time when a lake occupied the valley where Banff now lies.

10 *Mile* 7.0 Stop near bridge over penstock and note Kootenay beds of coarse sandstone and occasional coal inclusions, exposed in penstock trench.

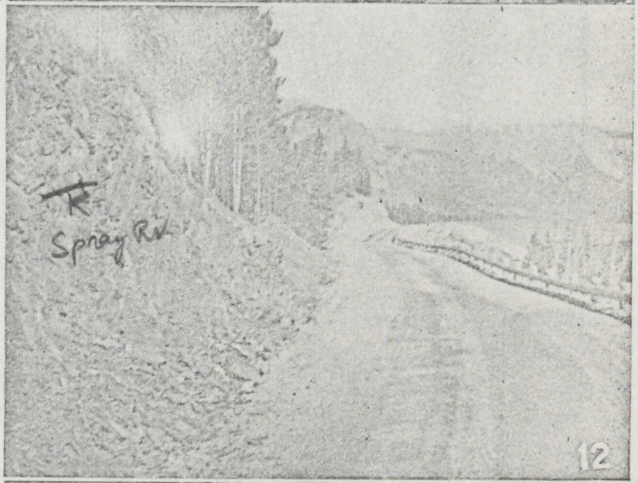
11 *Mile* 7.1 Cascade mountain, capped by Rundle formation, with Banff shale and Palliser formation in succession below, resting on wooded Kootenay beds at the base. Coal was at one time mined from these Kootenay beds over which the Paleozoic has been thrust.

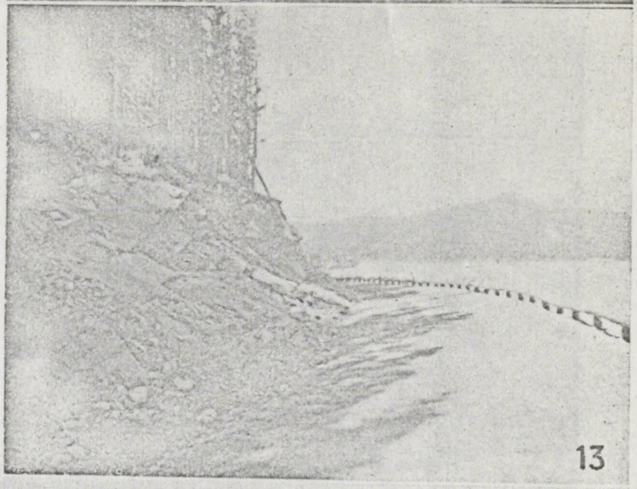
12 *Mile* 9.4 Spray River shale at the left. Fairly soft, but with some limy beds hard enough to yield flag stones. A hundred yards farther on, softer beds have been eroded to form a gulley. The next rock exposure is in Rocky Mountain formation.

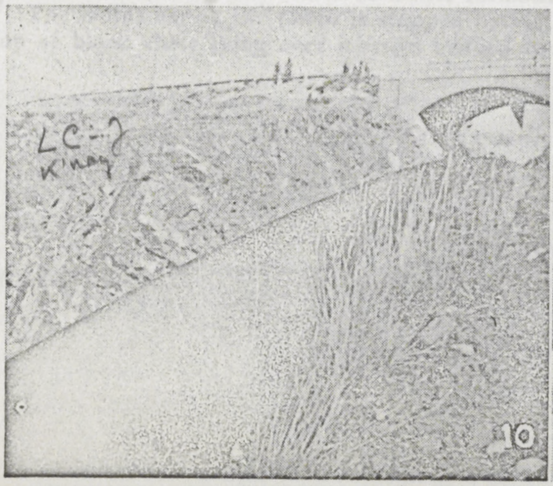
13 *Mile* 9.7 Beds of Rocky Mountain formation dip away from the lake. Bedding is more massive than those seen on the shoulder of Tunnel Mountain.

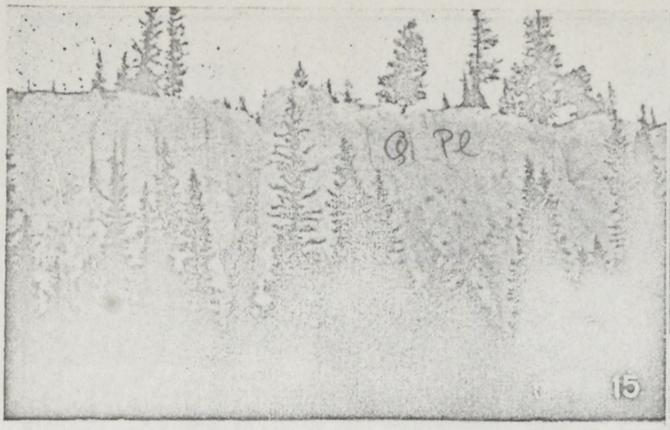
14 *Mile* 10.5 From the dam we see the type section of Minnewanka formation, with Palliser (Upper Minnewanka) forming the nearly vertical cliff. The gently sloping bench above the cliff is Banff formation, and Rundle tops the mountain.

Not pictured is a pre-Pleistocene outlet of the lake, found during stripping operations for the dam at its eastern end.









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The following photos are in sequence of distance from Banff Springs Hotel, with distance from Calgary in parenthesis. The Calgary starting point is at 16th Ave. and 10th St. NW.

15 *Mile* 6.5 (79.3) Hoodoos; formed in glacial till by differential erosion.

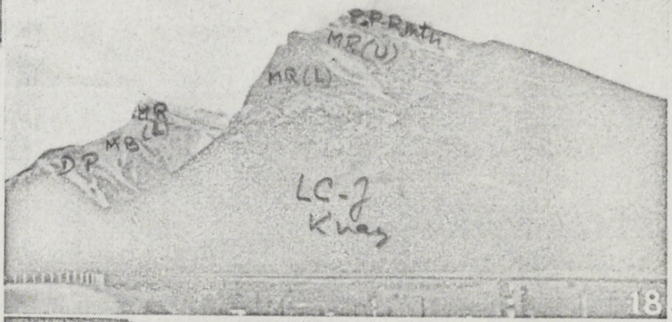
16 *Mile* 16.9 (68.9) Three Sisters. The right hand peak is Lower Rundle, the col to the left is Banff, the middle peak is Palliser, and the left peak is also Palliser, repeated by faulting. The three peaks have been thrust over Kootenay beds, which form the gentler, wooded slopes below.

17 *Mile* 19.7 (66.1) Panorama south of the river. Wind Mountain, later called Mt. Lougheed, is the rugged limestone peak with blunted top in the middle skyline. Its Paleozoic beds have over-ridden Kootenay coal measures and to the left they can be seen folded into a synclinal U.

18 *Mile* 21.6 (64.2) Pigeon Mountain is the nearer and is capped by Rocky Mountain and Upper Rundle formations with Lower Rundle forming the cliff. The more distant peak is capped by Lower Rundle. Banff shale forms the gentler slope, and rests on more resistant Palliser formation.

19 *Mile* 25.5 (60.3) After a turn to the left at the brow of a hill, the quarry for Exshaw cement plant shows its bare face on a mountain side. The quarry is in Palliser formation, the uppermost beds of which extend to a dark gully where posts protecting the road disappear behind trees.

20 *Mile* 25.6 (60.2) Basal beds of Banff formation. The motor car in the photo is stopped beside an outcrop of black shale lying over massive bedded lime-



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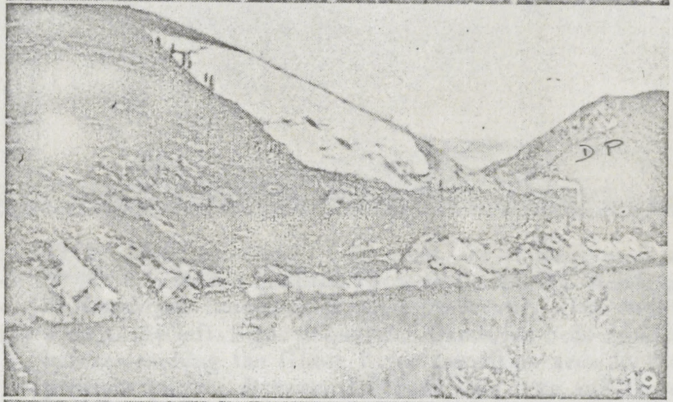

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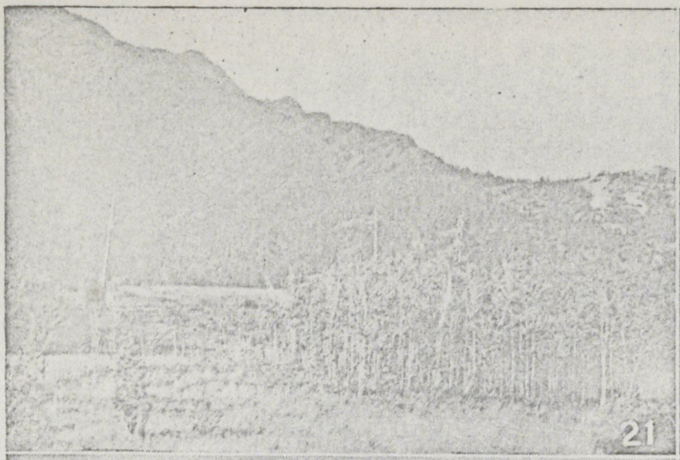
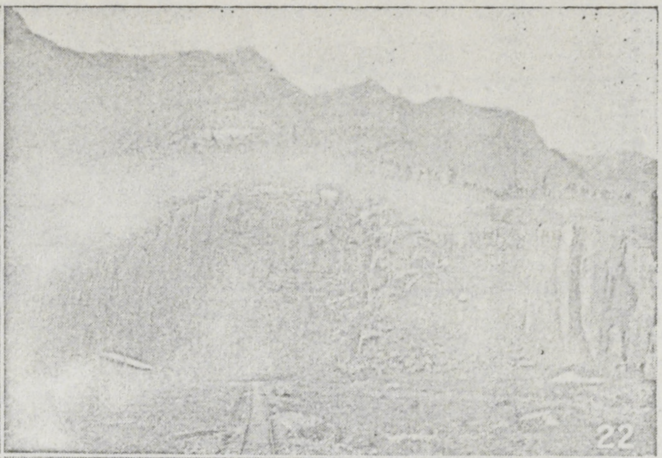
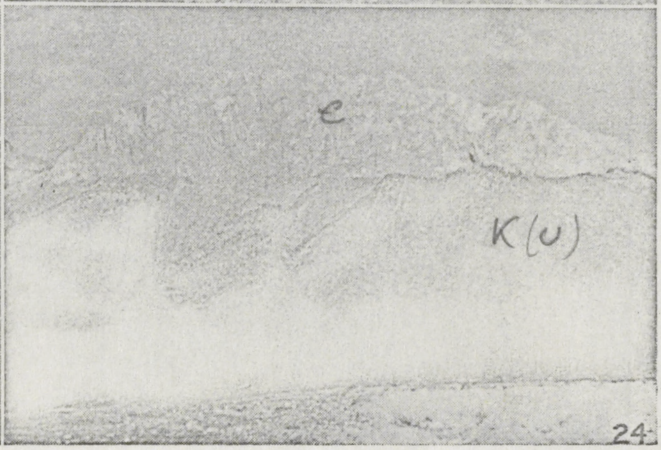






stone which gives topographic expression to the shoulder on which a telephone pole is planted. The gully beyond is an expression of the softer Exshaw shale marking the base of Mississippian beds, but the shale itself is covered.

21 *Mile* 28.9 (56.9) Approaching a lime kiln; to the north of the highway, in the middle third of the photo, one sees yellowish buff weathering beds of Ghost River formation, with drab dolomites of Fairholme formation lying above and rising in the left third of the photo. The two formations appear to have no angular unconformity.

22 *Mile* 29.1 (56.7) Park your car at the lime kiln and walk a hundred yards to the quarry. Bedding of Cambrian limestone is almost vertical, with upper beds at the left. Some unquarried Cambrian beds remain before reaching the Ghost River formation seen in the previous photo. Between the beds seen here and those of the Middle Devonian Fairholme is a very long time gap, but very little angular disconformity.

23 *Mile* 31.9 (53.9) Cambrian beds show contortion. A white bed appears to be repeated by thrust faulting.

TABLE OF FORMATIONS

	System	Series	Formation		Predominant Character	Conditions of Deposition	Thickness, feet
Cenozoic	Quaternary	Recent			Gravel, Alluvium	Subaerial, river	
		Pleistocene			Boulder clay, silt, sand	Glacial	0 to 100 or more
					Unconformity		
	Tertiary	Eocene	Paskapoo		Sandstone, shale	Fresh water	0 to 5000
Mesozoic	Cretaceous	Upper	Edmonton		Sandstone, shale, coal	Fresh to brackish	1000 to 2000
			Belly River		Sandstone, shale, coal	Fresh	2000 to 2800
			Alberta	Wapiabi	Shale, ironstone, minor, sandstone	Marine, off shore	1700
				Cardium	Rusty sandstone, pebbles, shale	" near shore	350
				Blackstone (Colo)	Black shale, minor sandstone	" off shore	1000
		Lower	Blairmore		Shale, sandstone	Fresh to brackish	1000
			Kootenay		Sandstone, coal		3400
	Jurassic		Fernie		Black shale, "ribbon" sand	Marine	1100
					Unconformity		
	Triassic	Lower	Spray River		Shale, limestone, sandstone	Marine, off shore	0 to 1520+-
Paleozoic	Carboniferous	Permian? Pennsylvanian	Rocky Mountain		Quartzite, dolomite, chert	Marine, near shore	700
		Mississippian	Rundle		Limestone, dolomite, chert	Marine	2400
			Banff		Brown weathering shale, limestone	Marine	1325
		?	Exshaw		Black shale, not limy	Marine	80
	Devonian		Minnewanka	Palliser	Limestone, massive, cliff forming	Marine	1050
				Fairholme	" thin beds, softer		1900
	Devonian Silurian Ordovician Cambrian	Lower … Upper			missing here in major unconformity		
		?	Ghost River		Buff weathering dolomite, quartzite	Marine	285
	Cambrian	Middle	?		Limestone, dolomite	Marine	1000+

24 *Mile* 32.9 (52.9) (Photo by J. D. Weir) Mt. Yamnuska's precipitous Cambrian limestones are thrust over the gentler slopes of Belly River rocks in the McConnell fault.

25 *Mile* 35.1 (50.7) Bowfort creek has incised deeply into Wapiabi shale of Upper Cretaceous age.

26 *Mile* 61.3 (24.5) Looking westward toward Wildcat Hills with irregular crest, formed by sharply tilted Belly River beds. Sandstone outcrops are marked by stunted spruce.

27 *Mile* 77.7 (8.1) Glacial moraine contains gravel derived from rocks to the west. Not until after passing east of Calgary does glacial debris contain materials originating in the pre-Cambrian shield. Apparently Pleistocene glaciers met in that locality.

28 Cutbank of Elbow river at Calgary Golf and Country Club, *south of the city,* shows Paskapoo beds of alternating fresh water sandstone and shale.

O. T. S. Officers

(continued from pages 48 and 49)

(L. R. THORNE)

Diamond, Alberta in 1937. The Company then sent him into the United States where he worked in the oil fields of Oklahoma, Texas and Kansas for a period of eighteen months. He then returned to Canada, bringing back with him the first electric well logging unit to enter the Dominion. Following a tour of service in the Royal Canadian Navy he returned to Halliburton to assume the duties of Field Superintendent. He held this position until March 1948 when he was transferred to Edmonton as General Superintendent.

(B. H. COREY)

the Alberta Petroleum and Natural Gas Conservation Board as a Field Engineer in Turner Valley and in 1941 moved to Vermilion. In 1942 he joined the Canadian Pacific Railway as Assistant Mining Engineer and later as Petroleum Engineer. Recently he joined General Petroleums of Canada Ltd. as Production Manager. He is a Professional Engineer (Alberta), member of the Engineering Institute of Canada, the Canadian Institute of Mining and Metallurgy, and the Alberta Society of Petroleum Geologists.

(W. B. DINGLE)

ada with Imperial Oil, Leduc Field, as District Civil Engineer and later District Engineer. He is a member of the executive of the Petroleum and Natural Gas Division of the Canadian Institute of Mining and Metallurgy and a member of the Professional Engineers (Alberta).

(F. K. BEACH)

tic measurement of gas production to supply a record of reservoir performance and provide estimates of remaining reserves was outstanding. He is a member of the Engineering Institute of Canada and has served as chairman of both the Calgary and Edmonton branches. He is also a member of the Professional Engineers (Alberta) and the Alberta Society of Petroleum Geologists.

(R. L. BINNING)

joined General Petroleums Limited as Director and Assistant Managing Director. In June of this year he became Executive Vice-President. He is a Director of Superior Oil Ltd., a member of the Alberta Exploration Syndicate and the Canadian Institute of Mining and Metallurgy. He is also Secretary-Treasurer of the Canadian Association of Oilwell Drilling Contractors which he helped to organize.

It's all nature's fault

Prairies slip into foothills: turmoil creates landscape

IN MID-PHOTO, A 'DRUMLIN' ON THE MORLEY FLATS
. . . like fingers of a giant hand

In this second installment of a four part series on the geology of the Calgary area, Herald reporter Don Truckey, with guidance from University of Calgary geology professor Dr. Len Hills, describes "thrust faulting," the process behind the formation of the foothills and the Rocky Mountains. Glacial features in the Morley area are also discussed.

Included are further locations between Calgary and the base of Mt. Yamnuska where notable features discussed in the series can be seen firsthand on your next trip to the mountains.

By Don Truckey
(Herald staff writer)

On Saturday we ended with the question: "Where do the foothills begin?"

And we found that the big hills around Calgary — Broadcast, Nose and Cochrane — are not foothills, contrary to popular belief, but river sediments which hardened into bedrock and withstood erosion to become "hills" in relief.

For our purposes a foothill has to be something more than a slab of rock that holds its own while everything around it washes away. There has to be some force, some 'pushing up' involved.

If we look at the question this way, we can get a very precise answer: the foothills begin right at the east end of the Jumping Pound Creek bridge as you drive west from Calgary on the Trans-Canada Highway.

Unnoticed, but still there

You drive right over it and never notice any difference in terrain, but that's because all the evidence is underground.

The evidence is called a "thrust-fault." It's the geological action which pushed up the Rockies and the foothills.

It works like this:

One of the world's major rock types is sedimentary. They are rock layers formed by the silting action of rivers, lakes and seas. The layers are laid down one on top of another, like the pages of this newspaper.

If you lay the paper flat and slide both edges toward each other you can create a little newspaper molehill. The sideways action you make with your hands is the same kind of force that acted on the flat-lying sediments of western North America 65-60 million years ago — an enormous lateral force pressing on the western edge of an entire continent (we'll get down to the ultimate reason for this in installment four).

But instead of neatly looping upward the way the paper does, the rock will eventually break and form what is called a fault line (see diagram).

As the pressure continues, the upper slab of rock slides over the one underneath it — and starts to rise. That's thrust-faulting.

It's not quite as peaceful as rustling the newspaper in your living room. Earthquakes are the result of the movements along fault lines. Shifts in rock positions up to 27 feet were recently recorded by geologists following earthquakes in the southern tip of the Alaskan panhandle.

The thrust-faulting which pushed up the Rockies probably proceeded through fault shifts of five feet or less, with accompanying earthquakes. Minor faulting and earthquakes are still occuring, but the Rockies will not likely rise much higher, because erosion is offsetting the upward thrust.

Bridge signals foothills start

None of this immense activity is apparent as you wisk past the Jumping Pound Creek bridge, but testing has shown that the bedrock beneath the surface to the east is flat with only a slight downcurve near the bridge caused by distortion from the fault.

Then just west of the fault line the rocks are tilted way out of kilter. That's the beginning of the foothills.

Since the rock layers west of the bridge have been shorn and thrusted upward, their bare edges break ground naturally in many places, and we've all seen spots where highway construction has cut through hillsides to expose whole sections of warped rockbeds.

Surface evidence of the first thrust-fault can be seen two and a half miles west of Jumping Pound Creek, where highway cuts reveal rockbeds slanted well toward the vertical. Faulting grinds rock into all sorts of contortions, but the east-end-up slant first encountered west of Jumping Pound Creek is common.

A well-known example of a clean thrust-fault slant of this kind is Mt. Rundle near Banff, where the entire mountain has been pushed up on a slant to resemble a gigantic wave cresting toward the east.

We've been talking about geological action which began 65-60 million years ago and has not yet ended, though the most intense thrust-faulting was over by about 40 million years ago.

We'll come back to thrust-faulting and the upsurge of the Rockies in installment #3, but before we reach the mountains our travels to the west bring us to Morley Flats, and we must bounce back to the near-present to discuss the surface geology of this area.

Back a few years

In Morley Flats we find glacial features formed around the same time that Glacial Lake Calgary existed (check installment #1 in Saturday's Herald).

As the description of thrust-faulting indicates, these glacial features are mere swirls on the surface of the vastly older and larger mountain geology, but they remain intriguing, especially since you can still see glaciers carving their own peculiar geology at the higher mountain altitudes.

We're back at 49-40,000 years ago.

Morley Flats, as everyone knows, is a level pan of gravel and rock. It runs 20 to 30 feet deep in "outwash gravels," beds set down by the melting, receeding Bow valley icesheet which was spilling into Glacial Lake Calgary (the western end of the lake was at the present townsite of Morley).

The last intense glaciation of the Pleistocene geological period (the "ice ages") was over by 40,000 years ago, although a lesser resurgence occured between 23-12,000 years ago.

During the final 9,000 years of the last big freeze, from 49-40,000 years ago, the tongue of ice issuing from the Bow valley melted on the spot and produced the glacial features we see in Morley Flats today.

The melting ice decayed and became weaker — the idea of melting and decay is important, because when glaciers start creeping forward again they sweep clear evidence of the previous melt (the Bow valley glacier did advance after 40,000 years ago, but only to near the present site of Seebe.)

It's also important to remeber that the Bow valley glacier was still *flowing* from the pressure provided by ice "upstream" in the mountains, but the pace of melting meant the leading edges were decaying and retreating into the flow.

And now about 'drumlins'

One kind of glacial feature common to Morley Flats are called "drumlins." These are large mounds of glacial till (gravel and rock) formed when the piedmont lobe (foremost bulge) of the glacier splits up and spreads like the fingers of a giant hand.

Glacial till collects between the 'fingers' and eventually piles up into a mound with a large rounded end tapering to a point — a drumlin. The bulging end is always upflow relative to the glacier, because it catches the most glacial till as the ice 'streams' by (recall that the glacier was still flowing when these drumlins were formed).

Thus the tapered end, which makes the drumlin look like half an arrowhead embedded in the ground, always points in the direction of the glacier's flow (see photo).

A whole field of drumlins are visible immediately north of the Trans-Canada Highway about a mile east of the Morley Road overpass. This is 13½ miles past the Jumping Pound Creek bridge by a strict mileage count, though drumlins and other glacially-formed mounds can be seen throughout Morley Flats.

Highway cuts revealing the gravels and rocks of glacial till also help distinguish the geology of this area from that within a few miles of Jumping Pound Creek.

"Eskers" are another glacial feature found in Morley Flats, snake-like mounds formed by waterways running underneath the decaying Bow valley icesheet.

Eskers follow the meandering paths taken by the sub-ice waters which laid down glacial till to form them, and are often over a mile long.

They originally took an inverted U shape in cross-section, but slumpage has worn them into inverted V shapes.

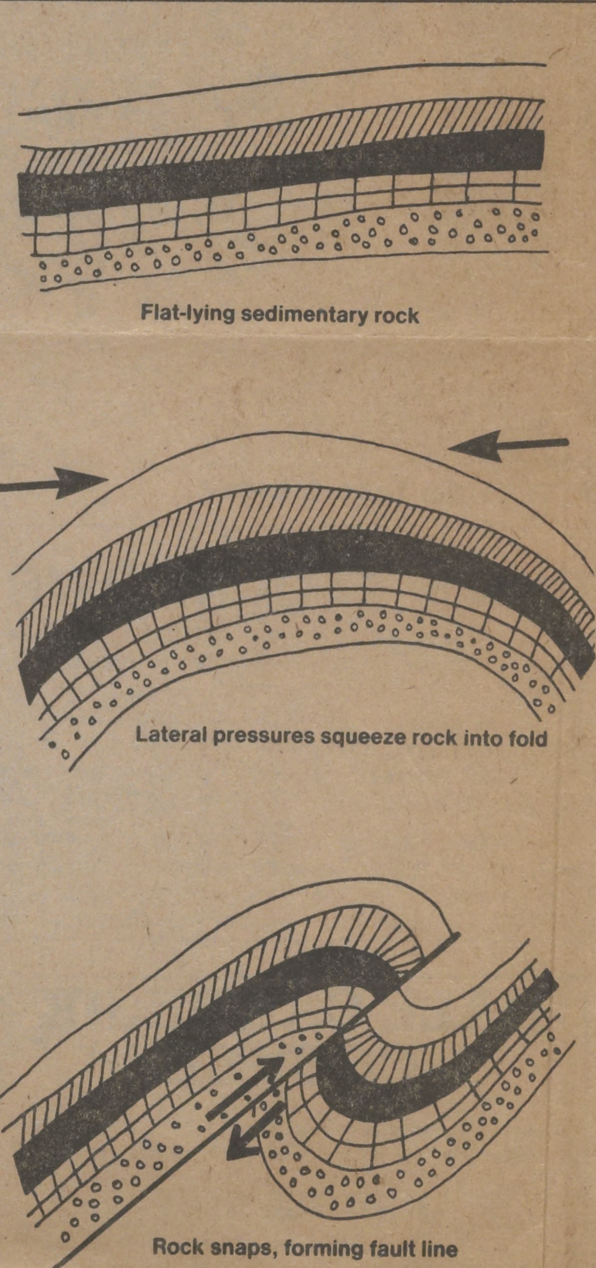
To conveniently see an esker, jog off the Trans-Canada on the highway 1A North turnoff to Exshaw. You will immediately come upon an intersection — the esker is 100 yards past it on the left (west). The department of highways has thoughtfully sheared off the end abutting the highway, so you can clearly see its compositon (...more gravel and rocks). A quick stroll along the top shows that the esker meanders just like the sub-glacial stream than formed it.

A mere 14,000 years old

For the geological record, this esker is thought to have been formed during the last retreat of the Bow valley glacier, between 14-12,000 years ago.

There were four such retreats. Most evidence of the first two was obliterated when the glacier advanced for the third time. The drumlins discussed above were left when the ice retreated after this third advance. The fourth advance, which formed the esker, did not extend far enough east to level the drumlins.

Our geological journey westward from Calgary has at last reached the Rockies. In tomorrow's third installment we'll take the biggest backward jump yet in our reverse story — to 650 million years ago — and find out how the Rockies were made.



(Herald drawing by Tim Adams)

Calgary

ey is to cover the council's
wo-week camp for about 50
veen the ages of 14 and 35,
place at Camp Horizon
Creek.

★ ★ ★

aunders has been appointed
director of the Alberta
hts Commission. He spent
ears in Edmonton as
director of the Alberta
ucation Centre but now
'al D'Or, Quebec where he
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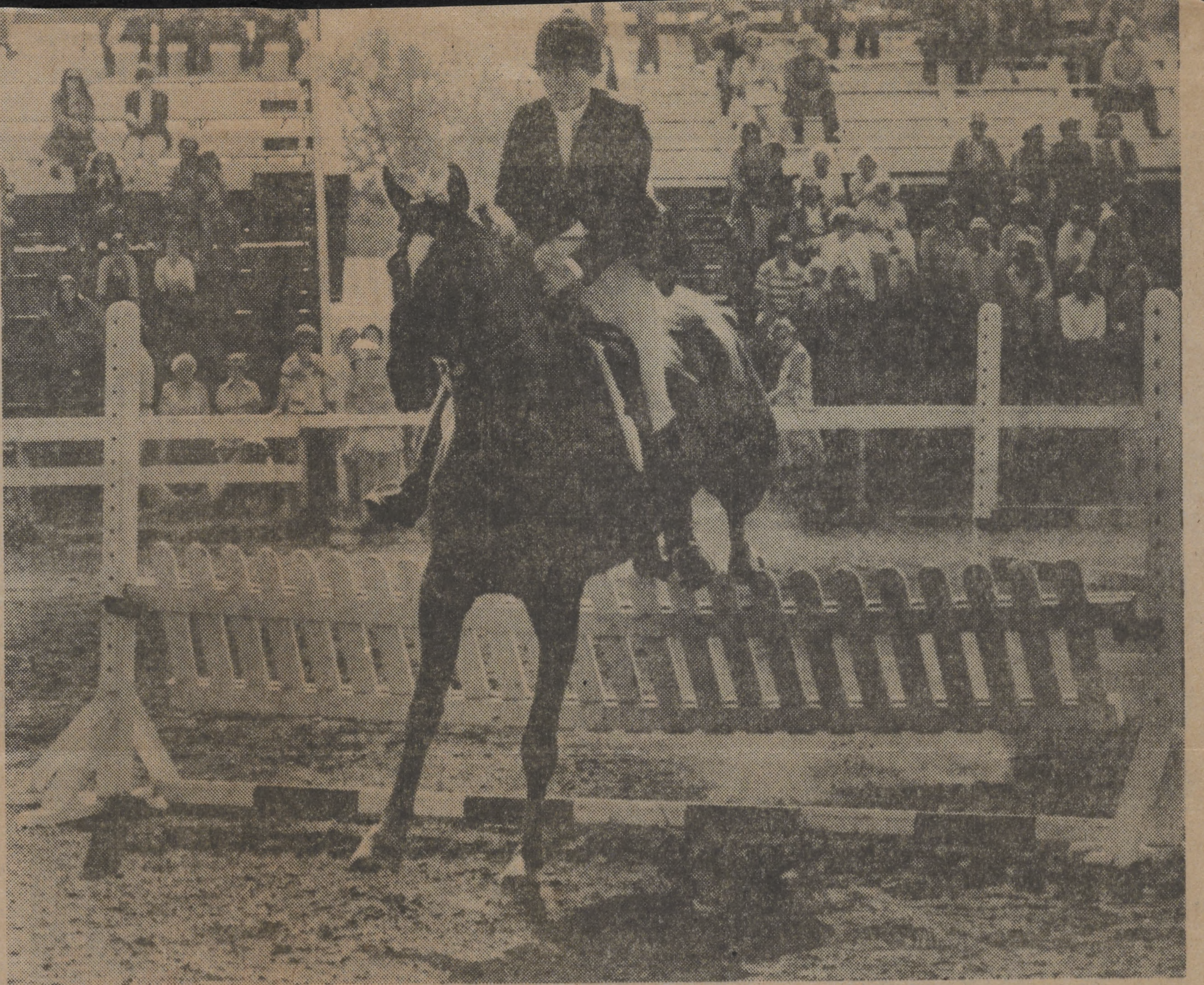
rd. His duties in Alberta
12.

★ ★ ★

who have lived in Calgary
re celebrating their 50th
niversary Tuesday. **Charles**
Thomson, of 400 block 22nd
will also be honored by a
held Friday at the Winston
mmunity Hall. Friends and
re invited to the event at the
treet and 27th Avenue N.E.,
o gifts on request.

mpiled by Paul Luft)



LAURIE HUGHES, 13, KNOCKED OVER THE FINAL GATE IN A JUMP-OFF

pioneer ldren

much more than in the last 20 years," he says.

A host of changes came shortly after he was named to his post.

The provincial government froze construction of new schools and parents angrily balked at having to bus their children to older schools; the government introduced early childhood education and learning disability funds; a five-week caretakers' strike crippled the system and damaged over-all morale.

During his term, Safran has seen educational attitudes change from the liberal, permissive approach of the 1960s to the conservative, "back to the basics" drive of the 70s.

He's seen school trustees and the public become more involved in education.

Parents now wage emotional battles over issues ranging from literacy to school closure, and the school board insists on running the system itself instead of leaving most decisions to administrators.

Safran is looking forward to leaving all the pressures behind and having a little spare time to think, write, create new theories in his special field.

oppy again

Parkvalley Dr. S.E. whose home overlooks a valley in Fish Creek Park. Wood said the previously 40-pound dog "hadn't eaten much and had lost 10 pounds."

"She didn't even know me at first. I had to put my jacket down and let her smell it."

The dog, who looks like a small lion and is of a breed known to be nervous around people, became the subject of a Herald story following her bizarre disappearance Aug. 9.

She happened to have been in a parked truck when it was stolen by a teen-ager from the lot of a Lake Bonaventure store. She later leaped out when the truck slammed into a motor home.

Police search for teen-agers

Police and civilians were today searching Ghost Forest near Cochrane for two Calgary teen-agers missing since Sunday afternoon.

RCMP at Cochrane said the youngsters — named as Fred Ponto and Susan Horbachewsky — have not been seen since they rode out of a campsite on Ponto's motorcycle.

"We are definitely concerned," said an RCMP spokesman.

Priddis and Millarville Fair

City and farm folk mix: a perfect day

By Dan Smith
(Herald staff writer)

Country fairs are supposed to be like the Priddis and Millarville 70th annual was Saturday — mom and dad and a million kids, long-eared rabbits, a lost pair of sheep shears and home-made ice cream.

More than 5,000 farmers, ranchers, and even lots of big-city dwellers took advantage of a perfectly- timed day-long break in the weekend rain Saturday to ensure the fair was its usual success.

In many ways, the Priddis and Millarville Fair typifies the unique sense of community that is the hallmark of a country fair. People — next-door neighbours living a section apart, or strangers from 100 miles away — whose daughter is up against yours in the sheep costume lead class.

★ ★ ★

Millarville-area resident Dorothy Jackson says laughingly that "you aren't allowed to move into this region without first agreeing to throw yourself into the fair.

"No, seriously," she adds quickly, "the way everybody pitches in is incredible. It really brings us all together."

There were no flashing midways or fancy dream homes being raffled away at the fair — just a leisurely-paced display of what it is to live in rural Alberta.

More than 600 exhibitors made the short walk behind the Millarville Race Track grandstand a fascinating blend of crafts, flowers, home-baking, prize vegetables and above all, animals.

★ ★ ★

Horses and 1,300-pound bulls meandered all over the place, guided expertly by amiable eight-year-olds, reins tightly-clasped in chubby little fists.

And for visitors from the city, the livestock exhibits and competitions offered an informative parade of enough barnyard characters to fill anyone's nursery-rhyme dreams.

There's about 18 different breeds of rabbit raised in Alberta for show purposes, for instance. And the French lop breed, which looks remarkably like a cross between a basset hound and an ordinary field rabbit, apparently does behave more like a dog in its love of human company than rabbits are supposed to.

★ ★ ★

This year's fair was saluting the heavy horse, and a number of afternoon competitions offered a colorful lesson in why the hard-working animals were such an integral part of early agriculture.

Teams of the huge animals were in heavy demand by kids all day, anxious for a ride around the fair grounds. Don and Joalane Swanston, with their heavy horse team from Cayley, Alberta, took home the Champion and Reserve Champion first-place ribbons.

But the people, and the relaxed, easy-going atmosphere they projected, made the fair a good place to spend a sunny Saturday. And that's the way it should have been.

'STEP RIGHT UP FOLKS, SEE THE BIG SHOW . . .'

Oman promises 'crackdown' on illegal suites

A city mayoralty candidate today warned he'll marshall "a crackdown" on illegal duplexes, fourplexes and basement suites in the city by "putting some teeth" into bylaws dictating the number of living units allowed in local buildings.

"Bylaw enforcement is lax and lacks teeth and as a result people are breaking the law," Ald. Ed Oman told a noon-time gathering of the Kiwanis Club.

He said there are "a prooliferation of illegal duplexes and fourplexes springing up all over the city" in areas zoned for lower densities and "all kinds" of basement suites in houses zoned as single-family dwellings.

Though he didn't have figures for the number of illegal units here, he estimated them to be "in the hundreds."

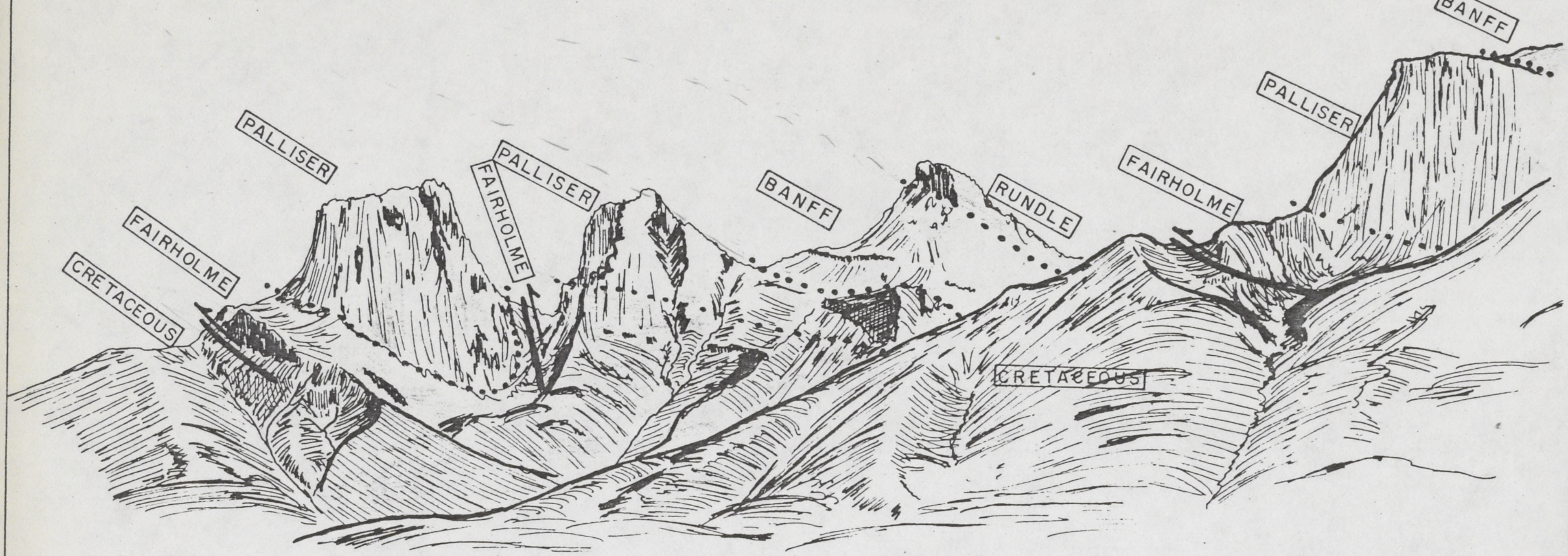
He blamed time-consuming enforcement procedures for the high numbers of overpopulated structures.

"When a bylaw officer is notified and says it is in illegal use, according to the (provincial) Landlord Tenant Act there has to be 30 days' notice issued. So for a month the place will be off the market and then there'll be somebody else in there and the whole process will have to be repeated."

Though the city does have powers, though court injunctions, to force tenants' evictions and close illegal living units, he said, "it's a lengthly proceeding. And often the landlord gets off on a technicality."

Oman added the proposed Alberta Land Act, expected to be passed this fall, "looks like it would give us a fair amount of power" to close illegal units.

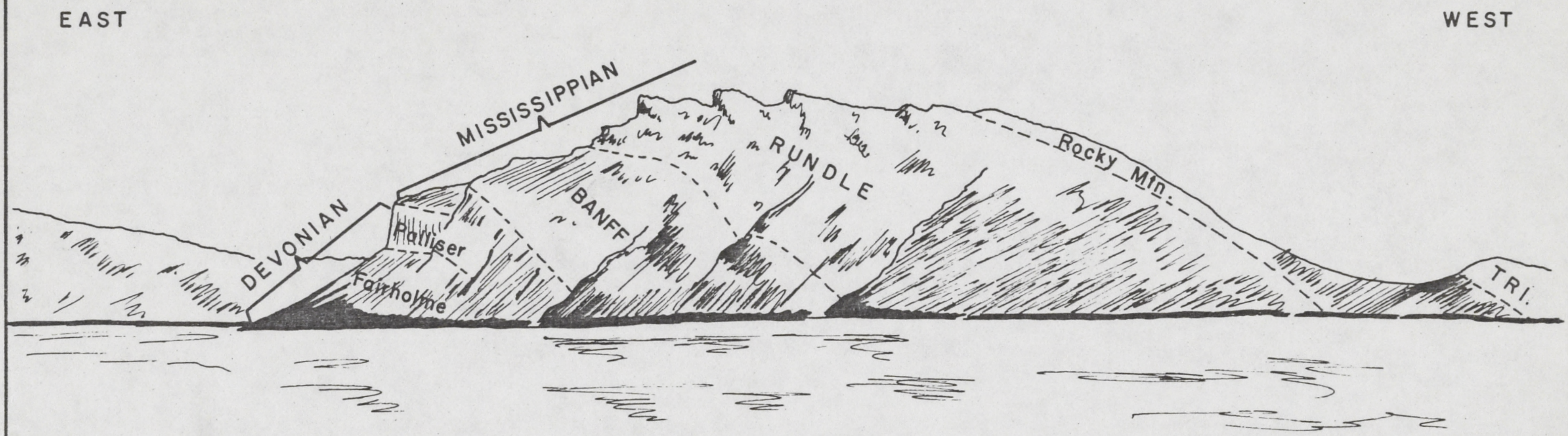
"So this is a warning situation," he said. "Fourplex buyers should insure they're in the right zoning areas.



THE THREE SISTERS - RUNDLE RANGE

FIGURE No 4

MT. INGLISMALDIE



LAKE MINNEWANKA

(Looking Southeast)

FIGURE Nº. 5